MANCHESTER METROPOLITAN UNIVERSITY BUSINESS SCHOOL

PhD Thesis

Potentially disruptive IS innovation in UK higher education institutions: An Actor-Network Theory analysis of the embedding of M-Learning

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Abstract

The use of mobile devices to support students' learning experiences is a growing area of interest in higher education (Wankel & Blessinger, 2013). This study adopts an 'umbrella' term of m-learning to consider the use of mobile and wireless technologies to support students in a blended learning environment. Whilst m-learning pedagogy has received considerable attention (e.g. Attewell, 2005, Sharples et. al. 2007, Kukulska-Hulme, 2012), the process of adopting this potentially disruptive innovation within universities has been neglected. This study addresses this gap by attempting to answer the research question:

> How do university organizations (business models, modes of operation, people and processes) adapt to a potentially disruptive innovation like m-learning and what factors and working practices support or hinder embedding?

Possible frameworks for studying innovation are reviewed, including Rogers' innovation diffusion framework (Rogers, 1962), Actor-Network Theory (Latour, 2005) , Activity Theory (Engeström, 1987), Structuration Theory (Giddens, 1984), theories of disruptive innovation (Christensen, 1997) and the Technology Acceptance Model (Venkatesh and Davis, 2000), Actor-Network Theory (ANT) is chosen as the most promising theoretical lens for an in-depth investigation of m-learning embedding, and a participative fieldwork approach is developed that uses Law and Callon's ANT notion of 'points of passage' between local and global networks (Law and Callon, 1991) to illuminate factors and working practices that affect embedding. A framework based on Law and Callon's work is developed through a year-long study of competing text messaging projects within a university and developed further through a three-year, longitudinal case study involving five universities using smartphone applications to assess students in medical practice situations. Several institutional issues are identified that help or hinder embedding, such as fragmentation of IT strategy and decision-making, and the need to provide students with a compelling offer of multiple institutional services on their mobiles. The role of people and artefacts in forming a link, or 'point of passage', between m-learning projects ('local networks') and institutional IT strategies and services ('global networks') is found to be of

central interest for understanding processes of embedding. A clear path to an ANT analysis is demonstrated starting from interview and observation data, using coding techniques borrowed from grounded theory (Schatzman and Strauss, 1973), and finishing with Law and Callon's local-global network model, which is used to compare and contrast embedding trajectories of the case study institutions. Systematic comparison enables a three dimensional model of embedding trajectories to be built, which extends Law and Callon's work and places in sharper focus the importance of establishing a path by which local initiatives can be evaluated strategically and, where appropriate, incorporated in a timely manner into a university's IT strategy.

Grounded in extensive longitudinal research, the study offers a contribution to methodology through its demystification of ANT; a contribution to theory through its three dimensional model for mapping embedding trajectories; and a contribution to practice by highlighting specific issues that affect mobile technology adoption in higher education, such as having a compelling, multi-service offer, appropriate mobile tariffs for undertaking mandatory assessment and guidelines for incorporating knowledge gained from technology experiments into institutional strategies and decision-making. The study concludes by highlighting opportunities for using its model to explore challenges of embedding faced not only by formal projects but by 'maverick' innovators and for potentially disruptive technologies other than m-learning, such as Web 2.0 services.

Declaration

I declare that I have not, whilst being registered for the PhD in Marketing, Operations and Digital Business, been a registered candidate for another award of any other university.

No material in this thesis has been used in any other submission for an academic award.

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Glossary of Terms

2.5G	GSM networks with high speed data support
3G	Third Generation Networks
4G	Fourth Generation Networks
ANT	Actor-Network Theory
GPRS	General Packet Radio System
GSM	Group Special Mobile (the most common type of mobile phone service prior to 3G)
HE	Higher Education
iPod	Portable media player
IS	Information Systems
JISC	Joint Information Systems Committee
MMS	Multimedia Messaging Service
PC	Personal Computer
PDA	Personal Digital Assistant
PRS	Personal Response System
SMS	Short Messaging Service
UMTS	Universal Mobile Telecommunications Service (3G)
WAP	Wireless Access Protocol
WI-FI	Wireless Fidelity

1. Introduction

Higher Education institutions are under pressure to adopt new information technologies to enhance their students' learning experience, reach new markets and retain students in an ever-increasing competition for a share of the higher education budget (Bradwell, 2009). This has been brought into even sharper focus by the recent changes to how HE will be funded through the 2010 Browne Report, which has references to improving online course information but also suggests that universities need to provide improved IT and library services (Browne and Great Britain. Department for Business, 2010). Universities are increasingly measured through student satisfaction surveys and employment outcomes not only as the main way of attracting good students and retaining them but also the government is placing students as the focus of the system and encouraging students to act like consumers, fostering a more competitive market between institutions and raising the prospect of more private providers. The implications of this new world where students have ready access to comparative data, is that universities with lower scores may fail to attract enough students to remain viable (Great Britain Department for Business Innovation and Skills, 2011).

Applying technology to teaching and learning may improve student experience but what if that technology challenges existing ways of working and existing processes for procuring and managing technology? Universities regularly procure and apply new technologies in their teaching and learning; the spread of Virtual Learning Environments (VLEs) is one example and this technology is now pervasive. The deployment of VLEs has been largely compatible with

existing teaching and learning methods (Brown, 2010) and they are centrally managed by an IT function so they appear less disruptive, except perhaps in their high financial cost and therefore due process of procurement and technical support. Universities have been procuring Enterprise Resource Planning (ERP) systems, Human Resource (HR) systems and student record systems so it can be assumed that as a sector, they have significant experience of procuring, implementing and operating complex IT systems, although it does not follow that they have always been successful in using them effectively (Christensen and Eyring, 2011). So, is mobile learning just another technology for a university to apply or is it going to create some new challenges which the institution will find difficult to accommodate?

1.1 Research Background

This research commenced in 2005, and the rationale for choice of subject was based on the researcher's considerable industry experience in the mobile telephony sector together with the recent completion of a Masters degree where the dissertation looked at mobile data usage in Customer Relationship Management systems. The subject of mobile learning was starting to get coverage as a topic with organizations such as JISC and it was apparent that there were a number of experimental projects in HE using technologies such as text messaging and a considerable body of pedagogic research was being published through organizations such as the Association for Learning Technology (ALT). Indeed the area of mobile learning was starting to generate its own interest groups and its own worldwide conference, mLearn (www.mlearn.org). It was also apparent that mobile data usage had transformed

some industries (e.g. parcel delivery) so perhaps mobile learning would have a similar transformative effect on Higher Education, or at least present some new challenges to the sector. At the early stages of this study, the key question was what aspect of mobile learning would it focus on, in order to present a different contribution?

The researcher comes from a background of a long career in Information Systems and was part of a group concerned with business information technology placed within a university business school. Yet mobile learning must somehow be connected to education and pedagogy so the research had a potential multi-disciplinary element. Indeed at the start of the research the subject was treated with some suspicion by the University Business School and for the initial months it wasn't clear whether it might somehow be better positioned within the Education faculty who already had m-learning research active staff. Through an investigation into the existing m-learning literature, exploration of the topic implied that it appeared to be the domain of education researchers and learning technologists who focused on the pedagogy of m-learning and its strengths and weaknesses. Aside from a few pages in one book (Kukulska-Hulme and Traxler, 2005), it appeared that nobody was researching the impacts of mobile learning on education institutions from the point of view of how it affected the working practices and processes of the university organization. Research seemed to be focussed firmly on pedagogy and even those who covered issues such as embedding were concentrating on the embedding of the learning method. Hence an apparent gap in which to focus the research was plainly visible. Now eight years on that still is the case for the

research community but the squeeze on funding that Higher Education now finds itself experiencing through the changes proposed in the Browne report, will surely throttle back funding on pedagogy research in this area and focus the sector on solutions which are sustainable within the new economic HE landscape. Indeed the funding crisis is encouraging universities to improve communication with students in order to improve their rating in the National Student Survey (NSS) and mobile learning is starting to get some consideration in the university strategy for learning and teaching technology (Traxler, 2013). When the research started, mobile technologies such as podcasting and use of text messaging were new innovations in HE, whereas now these are starting to embed and universities recognise that they will need to be funded and maintained (Wankel & Blessinger, 2013).

1.2 Developing the Research Questions

When the project started, views of the likely research questions were based around a loose set of areas of interest that needed to be refined to focus on specific research questions that would define this contribution. Examples of early questions that the researcher considered whilst conducting an initial scan of the literature were:

- Does wireless connectivity or use of mobile devices increase the level of service provided to students?
- Does it open up new forms of interactive learning that don't require a traditional lecture theatre or lab environment?
- Does it allow the university to reach out to new audiences?
- How does it fit within the university IT strategy?

- Are there security and privacy concerns?
- Is it cost-effective to run and maintain?
- Is there a social impact on the students and academic staff in terms of changing the way they learn and work?

This is a very wide ranging set of questions that cover aspects of pedagogy, IT service delivery and impact of innovation. It places the research at an intersection between information systems, business and education. On one hand, it concerns provision of an IT service to users which is in the domain of IS research and opens up issues around how a university IT provision adapts from providing a service via fixed access points (i.e. PC's on desks) to a more flexible model incorporating mobile devices and applications. In the business domain it may have impact on a university's business model and organization structure as mobile learning could have implications for issues such as the provision of buildings, the flexibility of working hours and ownership and depreciation of capital equipment. In addition, the questions refer to changing the ways that courses are delivered and students learn which crosses into education theory and effective pedagogy. So the research could potentially make a contribution in three areas:

1. To the area of innovation diffusion theories in that it looks at a potentially disruptive innovation operating in an education rather than business context.
2. To the study of business information systems in that it looks at new mobile technologies and their effects in a university context.

3. To education research in that it looks at the effect of new learning technology on teaching and learning.

A decision was needed on where to focus the research, so, given the background of the researcher in business and information technology, it was appropriate to focus on mobile learning as an innovation and specifically as an IS innovation in the university context. The researcher discarded any thought of looking at mobile learning pedagogy in detail as this was already a well-researched area and making a contribution to Education Research had never been an objective. This distanced the research from several of the above research questions particularly in evaluating whether it was opening up new learning methods – clearly an issue for educational theorists to investigate. However, the impact on pedagogy was still a factor to evaluate, as the reaction of both teachers and students to this new learning technology would have an impact on its diffusion trajectory and hence, some of the thinking of education researchers has been included in the study.

Following an initial literature review, a set of questions was developed to try to ascertain what the barriers were to the adoption of mobile learning in UK HE. These were translated into a semi-structured interview plan and an initial field study (see Chapter 4) involved interviewing experts in ten different institutions across the UK. It is difficult to categorise these in any one group: some were internationally renowned researchers in the mobile learning field, some were lecturers who were introducing this technology through their own efforts and some were attached to learning technology groups and were the institution contact for all matters of mobile learning. However, they were the most visibly active mobile learning proponents within their institution. Their responses

identified factors that acted as barriers or issues for mobile learning that would challenge the universities' normal mode of business operation. They ranged from difficulties with the charging models offered by mobile service providers, to concerns about security.

It was apparent from these issues that there were many barriers to the successful embedding of mobile learning. Although further research could refine those barriers and perhaps identify other issues, the focus of the research started to shift towards embedding. How would the term embedding be defined and what influence would that have on the research design? What would characterise institutions that had more successful strategies for embedding this new technology as opposed to those whose strategy didn't engage with this new learning technology? Were there influential characteristics about the structure of the IT provision or the way the university executive embraced new learning technologies that varied from institution to institution? Thus through reflecting on the literature reviewed and consultations with experts at ten universities, the research had arrived at a clear focus.

1.3 Focus on Embedding

In looking at potential models to understand the embedding process, Everett Rogers' model of diffusion is the most widely quoted source (Rogers, 2003) with its distribution curve looking at the trajectory of an innovation adoption. Apart from the obviously steep challenge of adding to such an established model, was it appropriate to look at mobile learning in this way given the technology would still be in its infancy at the end of the research, still in the realm of the 'early adopters' (Rogers, 2003, p. 283). But Rogers admits that some innovations don't

fit his model as they are discontinuous and radical (Rogers, 2003). Mobile learning held the possibility that it could be such an innovation. It was also apparent that people factors played a large part in the barriers identified and therefore the reactions of people and the politics and culture of HE institutions would be factors in trying to promote or resist mobile learning. However, the literature review also identified Actor-Network Theory (Latour, 2005) and its notions of networks and its ideas that these networks of people and technology could go through a process of change (translation) before evolving into some arrangement that can embed. Actor-Network Theory (ANT) had been widely used to examine numerous technology related projects from failure of an attempt to create an automatic metro system in Paris (Latour, 2002) to numerous Information Systems such as a study of the adoption of GIS systems in India (Sahay et al., 1994).

The area of ANT which is frequently discussed is its ability to treat objects as equal partners in the network, a principle known as symmetry (Callon, 1986a) and that had an attraction in that there were examples in the world of mobile technology where the capability of the technology starts to influence the behaviour of the people who use it. For example mobile telephony and in particular text messaging has influenced the way people conduct their social lives, giving them the ability to dynamically adjust their plans when meeting up. ANT's concept of the technology having 'agency' and exerting influence on a process of change, had a relevant feel in the realm of mobile learning.

A comprehensive review of ANT literature and its use in the Information Systems field, highlighted an article which looked at Law and Callon's (1992) local/global network model and applied that to an e-government project (Heeks and Stanforth, 2007). Law and Callon's study of the failure of a government funded military aircraft project highlighted the concept of links between networks and termed these networks as local (e.g. commercial partners building the aircraft) and global (the government and Ministry of Defence) (Law and Callon, 1992). They also discussed the impact of effective links or 'points of passage' between the networks as a source of problems in terms of poor communication and the ability of local networks to exert influence on overall strategy.

It was apparent that the mobile learning projects encountered in field research, in journal articles or at conferences, were local initiatives i.e. confined to one subject, department or faculty within the university. None originated from strategic planning by institutions to introduce the technology. And, as the majority of these were funded through research grants, the projects were struggling with the problem of how to get their innovations both embedded within their own areas, when funding sources were exhausted, and also embedded within the university Information Systems and Learning and Teaching strategies. ANT's local/global model appeared to be an interesting lens through which to examine the links between these projects and the overall university business strategy – looking for evidence of strategies or behaviours which encouraged embedding. Not only was this a contribution to practice in terms of how mobile learning might be effectively diffused but also a contribution to

theory in terms of ANT. Previous studies of the local/global model had been centred on projects which were top-down initiated. For example Heeks and Stanforth's paper looks at an E-government strategy (Heeks and Stanforth, 2007) imposed centrally and Law and Callon look at a national government contracted project (Law and Callon, 1992). However mobile learning projects are rarely centrally imposed but are localised initiatives that have to influence the university from a bottom-up perspective. The literature review and the researchers' tacit knowledge of university IT organization together with some early investigative fieldwork, revealed an opportunity to view a mobile learning project through the Law and Callon model (Law and Callon, 1992) examining the points of passage between the mobile learning project and the global IT strategy of the institution. As a different type of project, mobile learning as an initiative that was introduced through localised projects rather than top-down management directives, this represented a potential contribution to knowledge both in terms of extensions to theory and actionable knowledge on introducing mobile learning into a university.

Having reached this decision to use ANT and the local/global model, the research questions could now evolve into a final set which could be used to begin the detailed field research. The issues are summarised by the research question:

> How do university organizations (business models, modes of operation, people and processes) adapt to a potentially disruptive innovation like m-learning and what factors and working practices support or hinder embedding?

The contribution to knowledge is summarised as follows:

> "This PhD will apply Law and Callon's local/global framework aspect of Actor-Network Theory to bottom-up initiated mobile learning projects in order to analyse the impact of this potentially disruptive IS innovation on university organizations. It will also offer extended insights into theories of the embedding of potentially disruptive innovations in the higher education sector and inform practice in the introduction of a significant new technology".

1.4 Methodology

The final challenge was to choose a methodology for the field research. The analysis of embedding through Actor-Network Theory would be strengthened by researching more than one institution so a multi-institution study was appropriate. There is a full discussion of the choice of methodology later in this thesis, but the approach chosen was one of using case studies based on methods developed by Yin (Yin, 2009) but influenced by applications of case study research to IS (Benbasat et al., 1987) and the qualitative focus of Denzin and Lincoln (Denzin and Lincoln, 2003).

Through the initial field research, the opportunity arose to perform a longitudinal case study on what was, and probably still is, the largest and most complex mobile learning project attempted by the UK Higher Education Sector (Project MED). It involved five independent universities working in a cluster which had over one thousand Health students using smartphones to perform clinical assessments whilst out on practice. Not only did this offer an insight into the real

problems of using mobile learning in a new and challenging way, but also had the unique feature of allowing observation of how this interacted with the operational models of five diverse universities; following five different sets of actors in their journey towards embedding.

The methodological challenge presented by Project MED and the research overall was how to both handle a significant volume of interview and observation data and describe the resultant findings in terms of Actor-Network Theory in an accessible form that could be understood by both those who were interviewed and other researchers. Therefore it was felt prudent to try out both the methodology and the actor-network theory analysis on a simpler case (Project SMS) in order to maximise the benefits of the privileged insight into the five institution study. This pilot case study was a formative experience both in developing field research plans and procedures and in developing the approach to theory-building, sharpening the researcher's fieldcraft before the main undertaking (Yin, 2009). Accordingly the research was carried out on a text messaging project within a single institution (Project SMS) and the ANT based analysis with its emergent theoretical framework was then reflected upon to inform the fieldwork on the five institution study (project MED) and to confirm that the approach could yield expected contributions to knowledge and practice. This would effectively give data from six institutions. Even though five of them are part of the same project cluster, the approach to embedding was likely to vary between cluster partners and allowed for some comparative analysis to be done which would contrast both different barriers to embedding and highlight strategies that would inform the sector. In addition, this incremental approach to

case studies could also be viewed as a contribution in a methodological sense to researchers looking at technical change caused by disruptive innovation.

1.5 Thesis Structure

To guide the reader through the remainder of this thesis, the following picture (Figure 1) shows how the thesis is structured and how the main contributions are developed through the different chapters

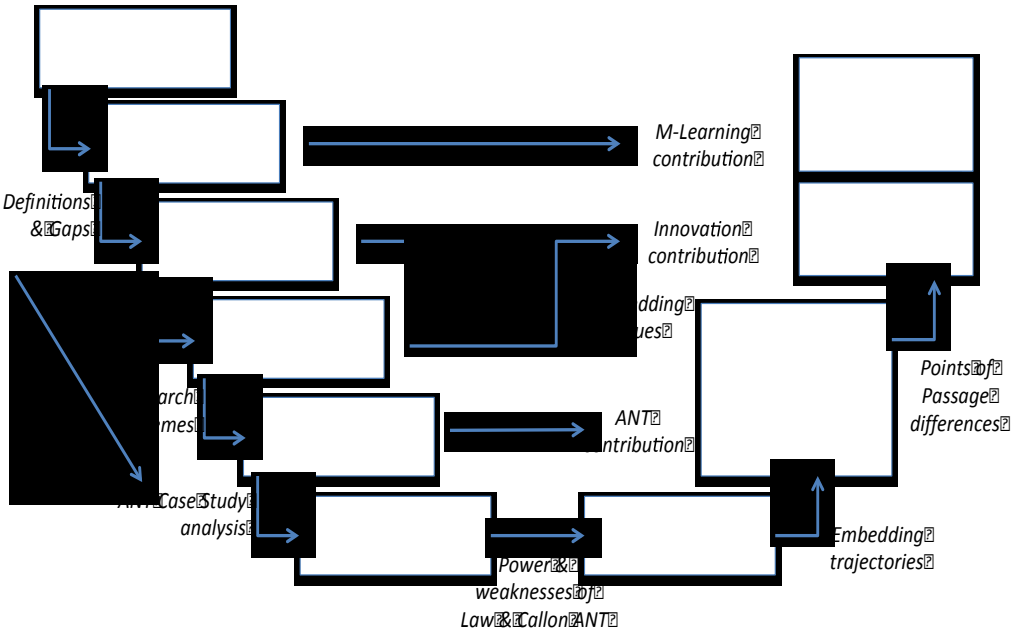

Figure 1: Structure of Thesis

The structure reflects the development of the research as it firstly narrows the focus and chooses a methodology and then subsequently refines the contribution to knowledge through a series of case studies. Chapter two defines the scope of

the term m-learning in relation to this thesis and reviews the m-learning literature to look for evidence of research into embedding. Chapter three is the main literature review which examines the topic of innovation and identifies ANT as the lens through which the research will be conducted. Chapter four describes an initial field study, a market research style exercise to find out the reality of m-learning in UK Higher Education at that time and triangulating the results of this with the literature review of chapters two and three, enabling the research questions to be chosen and in addition identify suitable m-learning projects which can be investigated.

With the literature review and initial field research informing the possibilities, chapter five defines the methodology, choosing case studies as the appropriate research strategy. Having narrowed the focus of the research and chosen the methodology, Chapter six (Project SMS) describes a pilot case study and Chapters seven and eight introduce and analyse the results of the major case study. Chapter nine discusses and reflects on the research results and finally chapter ten defines the contribution to knowledge that the thesis is making in terms of an enhanced ANT model to look at IT related projects and discusses possibilities for further work based on the thesis outputs.

1.6 Chapter Summary

The remainder of this thesis takes the approach that the focus of this research is a contribution to practice in terms of how institutions might position their strategies to enable embedding of mobile learning technologies and a contribution to theory in terms of how the ANT local/global model can be applied to understand processes of embedding. After examining the literature and

making a methodological choice, it presents the analysis of data from the two projects, and reflects on the findings. Significant factors are identified with regard to institutional IT strategies and the way that universities are segmenting their IT structures between learning technologies, general IT and network infrastructure. The relatively low-cost of some mobile learning services such as text messaging is also a factor coupled with weak or absent strategy that can lead to multiple solutions to the same problem, so –called 'competing translations' in Actor-Network Theory terms (Latour, 2005). Some unintended consequences and issues are also identified such as the need for established communication strategy within institutions to take full advantage of the reach of mobile technologies without causing confusion and uncertainty amongst both staff and students.

The thesis will demonstrate that Law and Callon's local/global model proves an effective lens for analysing and illuminating these issues. However, it will also point to weaknesses in the model when looking at these bottom-up initiated projects as opposed to the strategic projects to which it has been applied previously. An enhanced Law/Callon model is proposed in Chapter 10 to help future ANT based analyses gain new understandings, which is the major theoretical contribution of this thesis. The ANT-based analysis demonstrated in Chapters 6 and 8 will also help other researchers using ANT by using clear stages and diagrams to explain the analysis, providing a pragmatic illustration of the theory in use which is often only described in an abstract and theoretical manner in other studies and criticised as a 'problem of description' (Walsham, 1997, p. 476).

The next chapter will look at the term mobile learning or m-learning to both summarise existing literature but also arrive at a definition of m-learning that can be used for this research.

2. What is Mobile Learning and what can we learn from existing research?

This chapter is a short review of mobile learning literature as it relates to the topic of embedding. It is not a comprehensive review of the whole range of mobile learning literature as the main focus of the thesis is embedding and how that could be represented through theoretical models of innovation. It is also important to note that during the period of research, mobile learning has been transformed by the widespread availability of smartphones and tablet devices. The field research that underpins this thesis took place at a time when devices and network speeds were at an earlier stage of development. Literature and research available now, at the conclusion of the study, was not available to inform the fieldwork. For clarity a timeline for the research is included at the end of this chapter to clearly set the relationship between the literature and project timescales.

The term mobile learning or m-learning has been defined as 'using mobile and wireless technologies to support students in a blended learning environment' (JISC, 2005, p. 7). This is a broad definition that can encapsulate many forms of devices (mobile phones, portable PCs, tablet devices, mp3 players and personal response systems (PRS)) operating over both Wi-Fi and mobile service provider networks. What does m-learning mean in a university environment and what might typical usage be? The following are real examples discovered during the course of the research:

- Making lectures or study guides available as podcasts so that students can listen to them using devices such as iPods and smartphones, perhaps when travelling to/from college.
- Using text messaging to alert students when lecture venues have been changed or lectures have been cancelled.
- Performing assessment in a clinical training situation and using a handheld device to record the results of the assessment and submit them over the mobile internet so that they can be reviewed by tutors back at the university.
- Using personal response systems to capture student input during lectures or tutorials.
- So called WILD (Wireless Internet Learning Devices) knowledge gained from field research. Examples would be picture sound or other data gained whilst a biology student is visiting a remote site or map data gained from geographical surveys. The information is gathered via a handheld device and uploaded to university servers for further analysis. Some might consider that this is mobile learning in its purest form, learning that is developed from real world observation.

There is a wide mixture of usage here ranging from true mobile applications gathering data in field or clinical situations to administrative services such as text messaging, which could be considered as "m-administration" as opposed to m-learning. All however are part of improving the student experience consistent with government aims to place more focus on students as customers (Great Britain Department for Business Innovation and Skills, 2011). Such a wide range

of devices and applications has prompted debate amongst researchers in an attempt to establish an agreed definition of m-learning.

2.1 Definitions of mobile learning

This definition presents increasing difficulty as the convergence between handheld devices and personal computers develops. At the start of the research, devices such as the iPhone and iPad were not even forecast to appear. Now terms like "phablet" have emerged to reflect the increasingly blurred boundary between the some of the smartphone devices and the latest small tablet computers. Researchers have tried to split mobile learning into a number of categories differentiating between those services that were simply e-learning applications delivered on a mobile versus 'situated' mobile learning where the location of the device achieves some learning which couldn't be achieved by conventional methods (Traxler, 2007). Traxler attempts to contrast mobile learning as something more spontaneous and situational as opposed to the traditional models of 'tethered' e-learning (Traxler, 2007, p. 4). As well as the potentially spontaneous and student constructed learning differentiators, some researchers define m-learning more through the learner i.e. it is the mobility of the learner that is significant, the device is just an enabler (Sharples et al., 2007). This thinking that mobility is people-based rather than device-based forms the basis of Sharples' efforts to define a model of learning that can encapsulate the essence of mobile learning in a pedagogic sense. Another widely cited paper describes mobile learning as a 'new paradigm' in electronic learning focusing again on the issues of spontaneity and allowing the learner more choice (Leung and Chan, 2003). However, in 2003, it would have been less apparent that the boundary

between personal computers and mobile phones would become much harder to define and hence e-learning and m-learning would be harder to separate.

A simpler definition is "the use of wireless-enabled mobile digital devices" (Cochrane, 2010, p. 134) which fits the approach of this thesis. These definitions do lead to some debate on what is and what isn't mobile learning (El-Hussein & Cronje, 2010; Traxler, 2013) and 'it is easier to get a sense of the breadth of mobile learning than it is to get a stable definition' (Traxler, 2010b, p. 129). This thesis adopts the JISC definition: the use by students of wireless-enabled mobile devices in support of their studies. This broad definition will be the one used for the remainder of this thesis and will be referred to as *m-learning* in subsequent chapters, the italics confirming this definition as opposed to any of the others present in the m-learning literature. Key to using this definition is the notion that this thesis is concentrating on embedding of the technology within the university environment. Other studies are interested in the pedagogic merits of different uses of mobile technology. This research is concerned with institutional responses to the use of wireless-enabled mobile devices by students in support of their studies i.e. any use of mobile devices by students in a wireless or mobile service provider connected manner. This research is focusing on the impact on institutional processes and organisation structure so any debate about whether particular examples are mobile learning in a true sense is not central to the discussion. Note that the term mobile learning or m-learning (no italics) will be used for the remainder of this chapter as it refers to existing literature rather than the researcher's own definition.

2.2 Models of Learning

Putting aside definition issues, a major focus of existing research into m-learning has been in-depth understanding of the pedagogy and an attempt to develop models which can be used to understand and evaluate the effectiveness of m-learning. There are numerous theories around how mobile learning can be modelled in a pedagogic sense and what the characteristics of effective mobile learning might be, notably work done by Mike Sharples (Sharples et al., 2007). Indeed the focus of that research has been developing a model or theory on which to understand mobile learning much in the same way as e-learning research has developed models for e-learning theory. The essence of the theory being developed by Sharples and others is to capture the enabling aspect of mobility, embracing the concept that 'mobile networked technology can enable people to gain and share information whenever they have a need, rather than a fixed location such as a classroom' (Sharples et al., 2007, p. 224). The basis of this theory partly builds on work on models for using learning technologies (Laurillard, 2002) but is strongly focused on Activity Theory (Engeström, 1987) - a popular theory in education research and one which is discussed later in section 3.2. Other researchers have looked at the affordances that mobile learning may bring e.g. the nature of devices being small affords the learner the possibility of learning on the move or Web 2.0 services create new possibilities for learners (Cochrane and Bateman, 2010, Kukulska-Hulme, 2010, Bennett et. al, 2013). This concept of affordances is challenged as perhaps promoting the importance of the technology features over that of learner choice i.e. it is the learners who will drive usage not the technology (Wright and Parchoma, 2011).

This ANT based analysis of affordances differs from most articles by education researchers in that it uses actor-network theory as opposed to the more popular Activity Theory (Wright and Parchoma, 2011) but it is grounded in theories of learning. The relevance of this discussion on theories of learning is to demonstrate that although some meta-theories considered by this research such as ANT and Activity Theory are used with current mobile learning research, the focus is to examine the effectiveness of the learning achieved. This thesis will not attempt to evaluate how successful the learning is but will focus on examining the process by which an *m-learning* project becomes integrated into institutional ICT strategy.

2.3 About devices and practical issues

The research has also experienced an enormous shift in technology since it commenced and that applies equally to m-learning research. Earlier papers on this field certainly focused on the limitations of devices – such as small screens, keyboards, short battery life and slow network speeds (Kukulska-Hulme, 2005, Ryu and Parsons, 2009). These limitations are at least partially alleviated with the advent of smartphones, with longer battery life and fast 3G/Wi-Fi data connections. In 2005, smartphones were somewhat scarce and tended to be in the hands of very advanced users, whereas now they are in the hands of many students and staff. At the start of this research, the expectation was also that universities would have to supply smartphones to students if they wanted to embrace mobile learning. Now, a university could probably start to expect a significant number of students to arrive with their own capability in the form of personal smartphones.

M-learning researchers are not just focussing on smartphones but increasingly on tablet devices, especially the iPad, even using new terms to describe learning with these devices such as 'iPadagogy' (Cochrane et. al., 2013, p.48). The NMC Horizon Report for 2013 confirms widespread usage of tablet devices by universities (Johnson et. al. 2013). In the UK there are several examples of use such as Plymouth University using the iPad for art projects (Stillwell & Owens, 2012) and Manchester Metropolitan University using iPads for physiotherapy students (UCISA, 2014). The large-scale deployment of iPads in higher education institutions also raises similar issues to that of smartphones, namely the need for central IT services support and the debate between university supplied and student owned device (Mang & Wardley, 2012).

The issue of how to engage with students and devices is a moving debate as technology evolves. Projects that have tried to supply phones to students suffer from the problem of students not wanting to carry two devices, a personal one and a university one (Traxler and Riordan, 2004). The opposing discussion centres on the students' own personal mobile device and whether it is appropriate and ethical for an institution to interact with that space with some students raising privacy concerns (Traxler, 2010a). More recently there has been increasing focus on the issue of using student devices and terms such as BYOD (Bring Your Own Device) are used to describe this trend bringing new concerns about security and compatibility to IT organizations (Miller et al., 2012). The BYOD approach is seen as challenging institutions from an infrastructure, policy and procedure perspective with problems such as access to common software

across all student-owned devices seen as an issue (Nyqvist, 2012). This resonates with findings from the Project MED case study (Chapter 7) and the debate of student-owned versus university-provided device does emerge in the field research carried out for this thesis (see sections 8.3.3 and 9.1).

The disruptive nature of mobile devices is also well documented as educators agonise over the issues of students using mobile devices in a classroom situation and potentially creating disturbance for others (Campbell, 2007, Clark et. al., 2009, Pachler et. al., 2010). There is both the fear that this will disrupt learning activities and take away control from tutors who tolerate students with devices in the classroom – a suspicion that any use is for social and not learning purposes (Sharples, 2002, Selwyn, 2009). These suspicions do emerge in some of the field research found later in this thesis when Project MED is discussed in Chapter 8. Note that the term disruptive is used here to mean just that, disrupting a classroom, and should not be confused with the term disruptive innovation, which is also discussed later in Chapter 3.

2.4 Mobile learning and the institutional fit

What do mobile learning experts say about the issues of embedding? Much of their research concerns embedding the learning method, so when articles talk about embedding they are focusing on the learning method or model and how that can be maintained in the learning environment (Attewell, 2005, Motiwalla, 2007). In other words is the pedagogy effective and can it blend with other learning methods effectively? M-learning researchers are predominantly education researchers so are not focussed on the interaction of m-learning with

the university business model. A few of the leading researchers, however, have identified some of the issues. Traxler (2005) touched on the issues of mobile learning and institutional strategies and processes in a co-authored book on mobile learning. He gave pointers to potential problems within educational institutions such as changing the nature of work and altering work-life balance. He also pointed to issues around the technology in that it is unfamiliar to IT support staff and has different infrastructure issues than with PCs, in that mobile devices have a shorter useful life and by their nature cannot be installed in fixed areas (Kukulska-Hulme and Traxler, 2005). Traxler returns to this subject in a more recent paper discussing the challenge that m-learning brings to a university IT provision model which represents a 'benign industrialisation and electrification of learning' (Traxler, 2010a, p. 156), universities adopting this approach in order to deliver mass learning. M-learning is seen here as a potential shift in control from the institution towards the learner, requiring new ways of managing IT provision. A recent study of European mobile learning projects also acknowledges the apparent lack of strategy for handling this situation, asking 'to what extent are e-learning policy and initiatives taking account of research project results and the potential of mobile learning?' (Kukulska-Hulme et al., 2011, p. 152). Most papers, however, concentrate on models of learning and teaching (e.g. Wali et.al. 2008 Kearney et. al. 2012, Kukulska-Hulme, 2012). Overall, only Traxler (2005, 2009, 2010a) has consistently referred to how such learning interacts with the university business model and especially its model of IT provision. In terms of characterising mobile learning, this research does not try to make a distinction as it focuses on the issue of embedding into the institutional context. Already then, a gap in existing research and literature is

apparent, which offers this research an opportunity to make a contribution to knowledge.

2.5 Research Timeline

The topic of m-learning has evolved considerably through the timeline of this research project. In addition to the growing body of m-learning literature, there have been major developments with the technology moving from a largely 2G simple phone based devices in 2006 to today's ubiquitous smartphone and tablet devices. Against this development, it is important to contextualize the field research undertaken to illustrate that it was informed by literature available at that time and not by all of the literature contained in this thesis. For example, almost all the field research took place before tablet devices such as the iPad were being used by students in UK Higher Education.

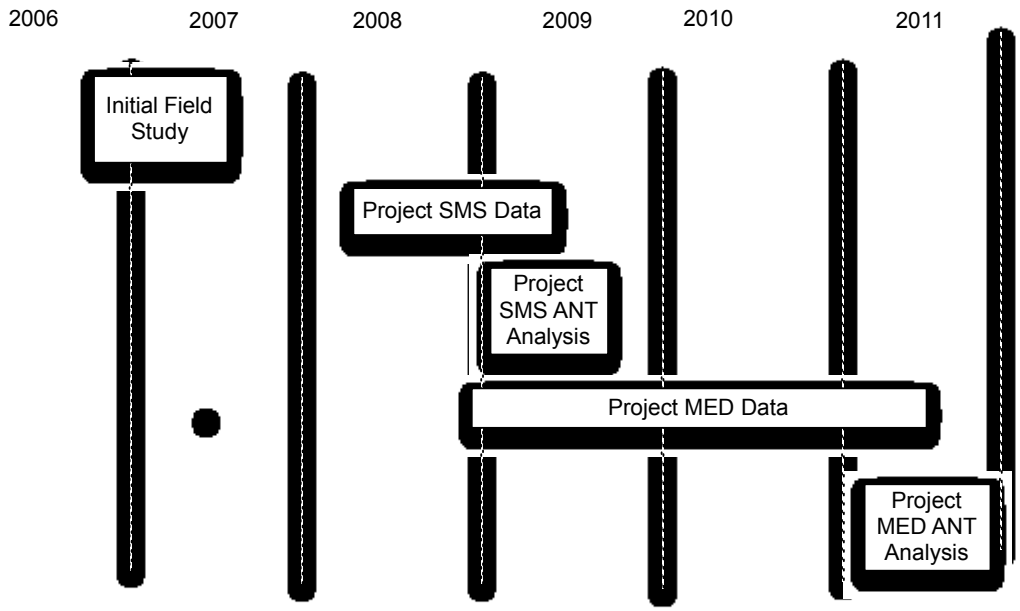

Figure 2 – Project Timeline

There are essentially three phases to the field research:

The Initial Field Study (2006-2007). This was a market research style exercise involving interviewing key individuals involved in m-learning at ten different UK universities.

Project SMS Case Study (2008-2009). This is a pilot study of projects using text messaging technology within a single institution.

Project MED Case Study (2008-2011). This is the main case study of a project using smartphone applications to assess students in medical practice situations. And involves five separate institutions.

This approach to the field research is discussed fully in Chapter 5 which discusses methodology. The literature review has been influenced by the findings from the field research, particularly the initial field study which helped sharpen the focus of the research. The initial field study is referred to in the next chapter on innovation literature and is covered in detail in Chapter 4 so the above timeline is to assist the reader in following the interplay between the literature and the research.

2.6 Chapter Summary

This review of m-learning literature had identified issues with the definition of m-learning, problems with devices, attempts to develop a model of learning that recognises the enabling power of mobility and first hints of issues around fitting

mobile technology into the institution and its IT and learning strategies. However even this rich body of existing research is challenged by continuing technology developments. The boundary between e-learning which was located traditionally on a PC and mobile learning which was assumed to be on a mobile device has blurred with the arrival of application-laden smartphones such as the Apple iPhone and those based on Google's Android operating system and tablet devices such as the iPad. Perhaps Sharples and others' assertion that it is the learner who is mobile and not the portable characteristics of the device, will become a more significant differentiator in the future (Sharples et al., 2007).

This convergence of e-learning and m-learning and the growth in mobile computing in education is a trend that has gathered momentum in recent years (Martin et al., 2011). The importance of mobile and wireless computing and the availability of many 'apps' is seen as key growth area in the next few years and one which will have to overcome barriers to change in institutional organization to be used effectively (Johnson and Brown, 2012). Those barriers to change in institutions are the focus of this thesis.

This literature review has revealed the definition of mobile learning to be a problematic, particularly in a world of increasingly sophisticated smartphones and tablet devices. There is a growing body of literature concerned with the pedagogic applications of mobile technology; however, beyond Traxler's thoughts about factors to consider, there has been very little written on institutional responses to mobile technology. There is therefore a real opportunity to make a unique contribution to knowledge on institutional responses to the use

of wireless-enabled mobile digital devices by students in support of their studies. As this phrase is unwieldy, the term *m-learning* has been defined for use within the rest of thesis. Note that this use of the term is different from those that seek to distinguish mobile learning from the provision of administrative information to students' mobiles – here it is used as an umbrella term.

The possibilities of a contribution to a deeper understanding of the embedding of *m-learning* have been identified but that needs to be brought within a business and information systems context. What guidance can be given to develop a study of *m-learning* embedding in an institutional context? Having adopted a definition of *m-learning* for this study, how will the term embedding be defined? To explore this area further the next chapters will examine literature on innovation diffusion and adoption of new information systems to seek out the most appropriate theories in which to ground this research and identify opportunities to focus on gaps in existing knowledge.

3. From Innovation Diffusion to Actor-Network Theory

The previous chapter introduced m-learning, reflected on the different strands of research relating to mobile learning pedagogy and put forward a definition of *m-learning* which will be used in this thesis, namely any use of wireless connected devices by students in pursuit of their studies. *M-learning* as an IS innovation potentially covers a number of areas of literature that included innovation itself, Information Systems, Learning Technologies, Information Systems in HE and mobile learning as discussed in the previous chapter. Given these are topics where a large body of publications exist, what would make this study different, what would make it contribute more than just another study of IS innovation? A systematic literature review for this area would lead to an overload of sources that would be way beyond the assimilation capacity of a single researcher. Therefore the strategy had to be selective by exploring these areas then looking for ways to focus the research and thus focus the comparative literature.

However, this poses several problems. Firstly, this area sits at an intersection between research on information systems, which is clearly in the business research domain, and research into use of technology in education (known as learning or instructional technologies), which sits in the domain of education research. This literature cannot be accessed through a common set of databases, the information systems articles accessible through databases such as ABI/Inform, Web of Knowledge and education articles accessible through the British Educational Index. There is a further complexity in that Information Systems are not referred to by a common keyword with other terms commonly

used such as IT, ICT, Learning technology and instructional technology. Thus a search on keywords requires several searches to bring up hits. Rather than search on keywords it was decided to look for articles that cited key innovation texts and then from this set, select a subset of the most referenced articles. For key innovation texts, citing Rogers innovation diffusion theory (Rogers, 1962) was the primary indicator of relevance with also some consideration to articles that cited the more recent theories of Clayton Christensen on disruptive innovation (Christensen, 1997). From these, other articles emerged from their bibliographies and also a search through relevant journals for articles published in the last five years for a more contemporary picture. As new ideas emerged, a similar strategy was involved to focus that research i.e. look for articles that referenced other relevant papers or relevant key words to always keep the research within a manageable focus. In reviewing the literature, the aim would be to progressively identify and highlight areas that suggested the possibility of different insights that could yield new contributions. In addition to the basic principles of the literature search, identifying appropriate theories was also assisted by the researchers' prior knowledge and what the term embedding might mean in the context of *m-learning* research.

3.1 Prior Knowledge and the meaning of Embedding

Before reviewing the innovation literature it is worth reflecting on whether the research is looking at student adoption of the technology or organizational adoption. In the case of *m-learning* and this project, the research is seeking evidence of whether the experience of *m-learning* projects is being assimilated into institutional IT strategy. This is actually a combination of what the

institution will provide in terms of *m-learning* services and whether this engages with students. Whilst student adoption is an important stakeholder in this scenario, it is not the single factor which will determine whether *m-learning* is assimilated or embedded into central strategy. It is one of a number of factors or stakeholders which will influence this embedding process. In looking at the innovation literature some factors identified will be more significant in terms of user (i.e. students and staff) adoption of *m-learning* and clearly whether students want to use this technology as part of their studies or staff are willing to incorporate it into teaching methods, has a clear impact on embedding. Other factors identified will have more significance in organizational terms. The evidence gathered from the literature review needs to balance these factors recognizing that many different stakeholders will have an influence on embedding. The researcher had also gained recent experience within Higher Education of the introduction of technologies and new processes and it appeared that stakeholder views were even more significant in an environment where decision making was driven more by negotiation and cooperation rather than imposed or necessitated by competitor activity as it might be in a commercial environment.

The researcher also has a background of senior positions within the IT industry over a thirty-five year period. The literature review was informed by the researcher's own tacit knowledge gained through experience of observing adoption of new information system technologies in both industry and the HE sector. Notably this experience involved seeing how the process of embedding new IT systems had unfolded in various scenarios. In that time, experience had

shown that a potential problem was the ability of pilot projects to build links into an organization's IT strategy. With this tacit appreciation acknowledged, it is worth exploring how the thesis will define embedding.

Embedding is a term that could have several meanings in the context of this study. One interpretation might be wholesale adoption of *m-learning* technologies by students in the same way that mass-market adoption of a product by consumers is viewed. Another definition might be adoption by the university where *m-learning* was a core offering used by a majority of courses taught by the institution. Neither of these scenarios was seen as a likely outcome at the time of this research given the stage where institutions had reached with research based or pilot projects. Therefore to look for signs of embedding within any of these widespread adoption contexts was felt to be unrealistic and the goal was to study some *m-learning* projects and look for evidence of a process by which these technologies might become embedded in time.

Constitutive process theory has been used to look at strategic change in organizations, notably ICI (Pettigrew, 1985) and has also been used to differentiate the focus of information systems studies (Walsham, 1993). Re-using an idea from constitutive process theory it is possible to consider an *m-learning* project as three interwoven factors. The *content* or the outcome of the *m-learning* project involves examining the output from the project such as the student take-up or effectiveness of learning; this is the area that *m-learning* researchers have tended to focus on. The *context* describes relevant contextual factors driving *m-learning* introduction e.g. is it a grant funded project or a

university funded pilot? The *process* examines how the project outputs interact with the university organization. Essentially it is this *process* that constitutes the focus of this thesis. The study is interested for given contexts in discovering what process led to more strategic outcomes and what differences in this process can be distinguished between institutions. Therefore, embedding, for this thesis is about the existence of an effective process for capturing at institutional level the project outputs. From prior experience, the effectiveness of the links between the *m-learning* project and the overall institutional ICT organization and strategy was felt by the researcher to be a key area to examine. Theories that might provide a suitable lens to evaluate these links were given prominence in the literature review.

3.2 Innovation Diffusion

The most widely cited framework for examining this topic can be found in Everett Rogers' innovation diffusion theory (Rogers, 1962). Rogers' (1962) original study of innovation in agriculture has formed the basis of most studies related to adoption and diffusion and four of his main ideas concern the diffusion process itself, the categories of people adopting an innovation, the attributes of the innovation and the rate at which an innovation is adopted. The diffusion process outlined by Rogers has five stages – knowledge, persuasion, decision, implementation and confirmation. Potential adopters have to be persuaded to utilise an innovation and following some trial period, adopters need to decide whether they continue to use the innovation or stop using it altogether. Diffusion is thus not a momentary act but an on-going process that can be studied, facilitated and supported. Categories of adopters are defined by their willingness

to adopt a particular innovation, from the "innovators" who take the lead to the "laggards" who resist adopting the innovation for as long as possible. Attributes of an innovation are used to describe the suitability of an innovation for adoption. An innovation is more likely to be adopted if the potential adopters perceive it is easy to try out, is compatible with their personal and professional goals, is simple to use, is better than the status quo and has demonstrable benefits (Rogers, 2003).

Rogers' work appears to be a good basis for investigating a new innovation such as *m-learning* but in a comprehensive review of diffusion research, he points to a challenge in investigating new technology innovation. That is the pro-change bias of the researcher, which tends to 'assume the innovations studied are "good" and should be adopted by everyone' (Rogers, 1976, p.295). This is perhaps a serendipitous warning for this research as *m-learning* projects are by their pilot and research nature 'early adopters' and likely to have champions who believe the technology is certain to both succeed and embed at unrealistic rates. Rogers also points to the problems of 'one-shot surveys' in drawing conclusions; diffusion is a time based process and this implies research needs to look at adoption from initial use through to widespread usage in an organization. This is another challenge for this research, in that it was never likely that it could observe *m-learning* projects from early adoption through to any form of majority usage within an institution; effective embedding strategies would have to be judged as those that are most likely to succeed in the longer term. Looking for evidence that *m-learning* projects are feeding into institutional ICT strategy is a more appropriate area to examine.

In trying to use innovation diffusion theory as a framework for studying m-learning adoption, it is appropriate to look at how Rogers' work has been used in studies of adoption of information systems and especially information systems to support student learning. Building on innovation diffusion, there are numerous studies covering the adoption of information technology, telecommunications and even wireless internet itself (e.g. Gurbuxani, 1990, Grover and Goslar, 1993, Malhotra and Segars, 2005). In a quantitative study of adoption of computerised manufacturing inventory control systems, factors which affected the adoption process were: the user community, characteristics of the organization, complexity of the technology, the task to which the technology is being applied and the organization environment (Cooper and Zmud, 1993). Therefore, in investigating university use of *m-learning*, it will be important to identify the benefits of the technology and how they fit into the institution's strategy. Similarly, a study of mobile internet usage in the USA utilised Rogers's innovation diffusion work to place users into five categories: innovators, early adopters, early majority, late adopters and laggards (Malhotra and Segars, 2005). Using a quantitative approach, they were able to group the users into Rogers' categories and then evaluate each group's mobile internet usage. They concluded that an evolutionary approach is required to introduce new services and that organisations need to carefully segment their service offerings in order to capture a wide user base. Since the definition of *m-learning* adopted for this study is any student use in support of their studies, it could be argued that segmenting and differentiating different users needs is not especially relevant. However there may be some significance that universities who offer more services to their users

(students) be they learning or administration features, may be making more progress towards embedding *m-learning* within their ICT strategy.

The innovation decision process may be seen as a temporal sequence of steps through which an individual passes from initial knowledge of that innovation to forming a positive or negative attitude towards it, to a decision to adopt or reject and finally through the adoption trajectory to embedded use (Rogers, 2003). The concept of adoption or rejection is perhaps too absolute in the case of Information Systems as in practice users may adapt an innovation to their own needs rather than accept or reject what is on offer. In research that combined innovation diffusion and attitude theories in an IT context, the beliefs and attitudes of users in pre-adoption and post-adoption (continued use) situation were examined (Karahanna et al., 1999). Pre-adoption attitudes are based on Rogers' set of innovation characteristics which affect the perception of the innovation prior to adoption and may affect the rate at which the innovation is adopted. The result of their study shows that post-adoption attitudes are based on social beliefs of how useful the innovation is and how using it will enhance the image of the user. This may be too simplistic a statement when it comes to a university. It will be important to identify that there are categories of user in a university with different attitudes and values including academic staff, students, administrators, IT service providers and information providers, such as librarians. Staff may have long-term interests in using an innovation, such as career enhancement, whereas students may simply have very short-term goals such as using the technology to complete a course module successfully. Therefore it may be that *m-learning* diffusion will not be primarily influenced by

how the technology enhances the social standing and image of the student that can use the technology as per Karahanna et als' study, but more by the social and career status of the academic staff. So a possible interesting research question and area that could expand current thinking on IS innovation in HE is the question whether staff 'steer' student adoption or could the inverse be true, students may 'pull' staff adoption in response to student needs? And what level of staff might be involved in this process; academic tutors? Or might it grab the attention of senior management and executive members (see section 3.4 for discussion of research questions)?

From a different standpoint Malhotra and Segars talk about the 'Behavioural Compatibility' where the innovation needs to be consistent with adopters' existing values and past experiences. With a more radical change in the way of working that mobile technologies can bring, other than the innovators of *m-learning* themselves, the early adopters may perceive a high level of behavioural change is required to use the new technology. Those proposing new wireless based services must convince the early adopters that the behavioural change is not as extensive as they perceive (Malhotra and Segars, 2005, p. 108). The initial field study (see Chapter 4) indicated that the predominant end-user, students, could be willing adopters but that there might be staff resistance for both cultural and lack of IT skills reasons. There is also the issue of the compatibility with the organization; *m-learning* challenging the working practices of areas such as procurement and IT. In early field research, IT departments in particular have demonstrated issues where mobile learning is not

seen as a core part of IS strategy and therefore not worthy of investing significant effort in.

Innovators by their nature are more venturesome and have a 'desire for the rash, the daring, and the risky' (Rogers, 2003, p. 283). They have a 'more favourable attitude towards change than do later adopters' (Rogers, 2003, p. 290) so may not expect the resistance they encounter. Rogers highlights the importance of early adopters as 'having the highest degree of opinion leadership in most systems' (Rogers, 2003, p. 283). This is another important factor that this research will look at to see how these barriers are overcome in introducing *m-learning* into a university and what strategies succeed or fail. Both the initial field study and the literature demonstrate that many initial *m-learning* projects are funded through short-term research grants (JISC, 2005, Traxler, 2013). How will they be embedded and developed once the research funding ends and they require university investment to continue? How will the projects progress from experimental pilots to make that link with overall IS strategy to become core services?

Cooper and Zmud also highlight the impact of organizational politics on an innovation where 'rational actions serve as facades to mask political motives and to legitimise self interest' (Cooper and Zmud, 1993, p. 136). The negative impact of politics on the success of an innovation is also discussed in a paper looking at new product development (Jones and Stevens, 1999). These political interests may be significant in this research into university environments which are subject to competition between academics for both position and research

funding, invisible pecking orders and sometimes very public disagreements (Becher and Trowler, 2001). The initial field study suggested that political positioning may play a part in both individuals who promote the technology and those who resist its introduction. An individual's response to an innovation in a free market (e.g. adopting a new product personally) may differ from their response when constrained by an organizational hierarchy (Rogers, 2003). The research needs to take care not to assume that all *m- learning* adoptions are the result of a rational choice of the individuals involved, nor will their behaviour be necessarily rational when asked to provide resources to the project and this also highlights the importance of gaining data from more than one institution to try to illuminate common barriers.

Rogers' theory is very much centred on the innovation itself and therefore doesn't focus strongly on political aspects associated with change, the drive towards diffusion are very much dependent on the characteristics of the innovation itself. Rogers does look at the characteristics of both innovators and adopters (Rogers, 1995, p.267) but again this is with reference to the innovation itself. From the literature on *m-learning* and the researchers' own initial field study, there appeared to be no shortage of staff within HE willing to investigate *m-learning* and an apparent audience of tech-savvy students or 'digital natives' (Prensky, 2001) willing to give this a try. What seemed to be missing was an examination of the challenges of negotiating an *m-learning* innovation through the complex political agendas that exist within institutions and the somewhat distributed nature of the various institutional strategies such as IT and Teaching and Learning. What was needed was to look more at the people aspects of

dealing with *m-learning* and how the various organizational functions that constitute an institution, might cooperate to create successful embedding. Consideration of the researcher's prior knowledge also indicated that a theory that would illuminate the different needs of stakeholders could offer a better approach.

There are theories and models that look more at the reactions of people to innovations such as Actor-Network Theory (Law and Hassard, 1999). Actor-Network Theory (ANT) has the concept of 'agency' (Latour, 2005) and states that agency resides both in people and objects such as innovations. It insists that all entities, both human and non-human, be subjected to the same process of social analysis (Law, 1994). ANT identifies the set of processes involved in projects of social ordering as networks and looks at the changes that take place in those networks through a project. ANT has the concept of translation where the people, objects and processes have specific needs which then get translated into more general and unified needs so that needs are all met by one solution. When a system is up and running it gets adopted by the users by translating it into their own context and reflecting their work tasks and situations (Latour, 2005). It also has the concept of irreversibility where a network is established and can resist competing translations and therefore the change becomes irreversible. Actor-Network Theory may provide a useful model for looking at *m-learning* in higher education as the various actors (the university, teachers, students, IT services, the innovation itself etc.) go through a process of translation in order to find a stable way of working together. Are there important differences that this will identify between universities that successfully embrace and implement *m-learning* and

those that are unable to 'translate' irreversibly? The possibility of viewing the local *m-learning* project and the university IT organization as networks that will need to intersect, fits well with the definition of embedding discussed earlier in this chapter. ANT appears to be a very promising lens for looking at the adoption of *m-learning* and a deeper examination of the ANT literature occurs later in this chapter (see section 3.3).

Aside from the actor-centred transformation view championed by ANT, there are many examples where information technology has been used to change the way that organizations work - the internet being an extreme example of radical changes to areas such as retail and travel (Hammer and Champy, 2001). Technology may be seen as an agent of institutional change and indeed *m-learning* may ultimately lead to different ways of delivering courses and in turn lead to a different structure and staffing needs. Innovation Diffusion theory is based on assuming that individuals make rational choices and weigh up the costs and benefits of an innovation in a systematic manner and from an individual standpoint (Redmond, 2003). The adaptive strategies of individuals will vary from those who like to take risks with new technologies to those who suspect that they may be an attempt to reduce costs and achieve a service with fewer resources notably staff, and in effect view the innovation as just a new labour control strategy (Braverman, 1974, Tinker, 2002). Students and staff will not simultaneously embrace change because individuals differ with respect to perceived risk/reward of adopting new technology (Redmond, 2003). Thus different universities may embrace *m-learning* at very different rates depending on their openness to new ways of working and the relative power of staff. This

resonates with an earlier discussion on the impact of politics on an innovation trajectory (Cooper and Zmud, 1993). There is also an echo here of Karahanna et.al.'s notion of social status and whether staff will 'push' the innovation on the students or whether the students will 'pull' the innovation into the university (Karahanna et al., 1999). In other words whose risk/reward needs will dominate, students or staff? The sort of thinking championed by Prensky's model of digital immigrants and digital natives (Prensky, 2001) would suggest that staff will be slow to pick up these new technologies but that students will be a ready and willing tech savvy customer base, but will that reflect reality? Indeed the Prensky model has been critiqued as simplistic and other terms such as 'Visitors' and 'Residents' have been proposed using the metaphor of place, removing the focus from the generational divide (White & Le Cornu, 2011). It also worth noting that training of students to use new learning technologies and training of staff to re-design pedagogy to utilise such technologies is a more significant issue than any perceived generational attitude (Beetham et. al, 2009). A final factor in the push/pull debate would be who owns the space in which learning can take place. The traditional university IT model is one of desktop PCs in drop-in centres where the university clearly owns and controls the IT environment. The mobile space is clearly going to be shared between the students with their personal range of mobile services and the university providing some of its own services. Will students welcome university applications on their own devices or will universities try to implement a model where they provide advice and thus can exert control? The move towards personalised learning is already seen as a challenge to the traditional HE IT approach and it is widely predicted that a shift is in place in education where learners will use their own personalised devices as

opposed to institution provided equipment (Johnson and Adams, 2011, Nyqvist, 2012). The issue of student-owned versus university-provided device strategies is extensively covered in the Project MED case study (see Chapters 7 and 8) and summarised in Chapter 9 Section 9.1.

IT diffusion behaviour is also influenced by senior management support, the centralization or de-centralization of decision making, organization size and IT function size (Pervan et al., 2005). Organizations that are characterised by decentralized structures and less formalization are likely to be more innovative than highly centralized organizations which use formalized controls (Pervan et al., 2005). Similarly research into telecommunications technologies suggests that more of these tend to be evaluated and adopted in 'decentralized cultures' (Grover and Goslar, 1993, p. 154). In decentralised structures, knowledge and decision-making may be 'located anywhere in the network' (Burns and Stalker, 1961, p. 121). Conversely, you might expect centralization to favour efficient implementation and deployment. Grover and Goslar's survey of U.S organizations concluded that centralized decision-making, neither favoured innovation nor implementation when it came to telecommunications networks. Having dispersed groups of expertise across organizations tended to provide a natural coordination which actually assisted introducing new networking technologies (Grover and Goslar, 1993). Another survey of the diffusion of networking technology concluded that a key factor in fast diffusion was the 'prior existence of a well defined community with shared interests' (Gurbuxani, 1990, p. 74). In looking at *m-learning* in an HE context, there appear to be many different stakeholders involved, including students, teachers, researchers,

librarians, IT Services staff, finance and management. Adoption of *m-learning* is a potentially complex process which balances the requirements of this diversity of stakeholders. On the other hand, a lot of funding and the IT strategy in universities would appear to be centrally managed and controlled (Allen et al., 2002), so will it be a case of local decision making aiding the innovation or central decision making hindering the adoption? A new technology such as *m-learning* may also prove to have a niche deployment rather than widespread diffusion across all faculties and universities.

A possible model for looking at *m-learning* diffusion is found in work carried out by the Global Diffusion of the Internet Project (GDI). In a paper reviewing studies of internet diffusion in 25 countries, a model was developed with six dimensions which cover the sophistication of the users, the organizational infrastructure, the networking infrastructure, the geographic dispersion of the user base, the maximum potential user base and the adoption within a specific industry sector (Wolcott et al., 2001, p. 6). Some of these factors reinforce points already seen in the other literature; such as the way an organization is structured (Pervan et al., 2005, Rogers, 1962). However, the model adds new dimensions such as geographical dispersion which might provide an interesting research question in the university environment. Are universities with geographically dispersed campuses more likely to embrace the *m-learning* technology than those located on one site?

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When an organization purchases a new technology it doesn't necessarily follow that they will start to use it. There may be a gap between organizations acquiring

a technology and deploying it, a so called 'assimilation gap' (Fichman and Kemerer, 1999). This is very relevant in IT purchases where organizations purchase some new technology but it stays on the shelf for a period of time before it gets installed and used, or in some cases it remains 'on the shelf' forever (Glass, 1999). An innovation is not necessarily embedding if it is made available to students and staff but is only sparsely deployed. This is surely a risk in a university environment where new technology may be acquired through some funded project and support for it may lapse when the funding runs out, even if the service is still available – a risk when many of the early *m-learning* projects have been focussed on generating research outputs. Thus the research needs to be able to distinguish between organizations which have purchased *m-learning* technology and those who are actually deploying it.

One further factor which may significantly influence the diffusion of *m-learning* is the concept of networking where networking is defined as the participation of key individuals in national programmes or collaborative projects between multiple universities. Rogers recognised that a key characteristic of innovators are their diverse social networks: 'Communication patterns and friendships among a clique of innovators are common, even though those individuals may be quite geographically distanced' (Rogers, 2003, p. 282). In a study of computer-aided production management technology across commercial companies in four European countries, professional associations are an important source of knowledge in the diffusion of innovations (Swan et al., 1999). Research on the impact of networking in the business sector on innovation diffusion has found that the more involvement individuals have in forums and professional

associations, the more likely it is that their organizations will adopt new innovations (Pittaway et al., 2004). There are a number of professional associations which support introducing new technologies into UK universities (notably, JISC and its technical information advice service CETIS (Centre for Educational Technology and Interoperability Standards) and the research based Association for Learning Technologies (ALT)) and their influence on successful *m-learning* diffusion is potentially a factor to investigate, although it was not significant in subsequent field research. Also significant may be the effects of networking between different faculties and between faculties and central services within a university. Will universities that have good networking across these organizational boundaries, also prove a significant factor?

The literature review has so far concentrated on an innovation diffusion process which follows the 'non-radical' characteristics and models proposed by Rogers (Rogers, 1962). Sometimes an innovation is so radical that 'it creates a high degree of uncertainty in an organization' (Rogers, 2003, p. 426) and thus fosters increased resistance from the organization. Such radical innovations are also called 'disruptive' or 'discontinuous' (Rogers, 2003, p. 426). Rogers recognizes that computer technologies often encounter 'special difficulties' (Rogers, 2003, p. 426) in their implementation. Innovation can be understood as a multidimensional phenomenon where the dimensions relate to technology, market and organizational change (Green et al., 1995) and 'environmental alterations' (Lettl et al., 2006) where environmental refers to infrastructure or regulatory changes. For example an innovation can be radical in the technical dimension if knowledge about the technology differs radically from current

experience (Afuah, 1998). From an organizational perspective, an innovation may be radical if it requires the organization to undergo major change in structure, strategy and culture (Lettl et al., 2006). *M-Learning* might be an example of this, in that it is an unfamiliar technology and may require significant changes to the way a university operates and consequently doesn't follow the Rogers model of diffusion. It is important to acknowledge that *m-learning* is a potentially disruptive technology in the HE context; the degree to which it proves disruptive can only be judged through its subsequent implementation.

Disruptive innovation has become a subject in its own right led by the work of Clayton Christensen (Christensen, 1997) on the impacts of disruptive technical innovations on business, notably using studies of companies that failed to move from existing established technologies to what became their replacements in the market. An example of disruptive innovation often used is that of the companies that failed to switch from manufacturers of mainframe/minicomputer products to PC such as Digital Equipment Corporation (Christensen and Overdorf, 2000). These theories of disruptive innovation divide innovations into two categories: sustaining innovations that make a product or service better in a way that existing customers value as opposed to disruptive innovations that create an entirely new market but where the innovation may initially be judged worse in the first instance through the measures that customers judge mainstream products (Christensen, 1997). An example would be digital photography where early cameras were far inferior to traditional film-based cameras but quickly captured the consumer market leaving some companies dominant in the old technologies

unable to adapt their business models to succeed with the new (Christensen, 1997).

Can this theory of disruptive innovation be applied to *m-learning* in higher education? If *m-learning* is seen as a replacement or evolution of e-learning then an argument could be developed that *m-learning* in its initial form has small screen/keyboard sizes, slow network speeds and lacks access to enterprise level systems such as student records and thus provides an inferior user experience to e-learning. As devices and network speeds improve and users start to value the advantages that mobility of device brings, then the university business model is potentially challenged to support these new ways of working. Christensen has also recognised that disruptive change is at work in higher education, albeit that his work does not explicitly cover *m-learning* (Christensen and Eyring, 2011). This work does however recognise the disruptive force of new technologies on a sector which has operated without significant organizational change for a long period –'until the relatively recent emergence of the Internet and online learning, the higher education industry enjoyed an anomalously long run of disruption-free growth' (Christensen and Eyring, 2011, p. 18).

Whilst Christensen might provide one suitable lens for this research, these theories of disruptive innovation are not without a considerable body of critics (Yu and Hang, 2010). Perhaps because Christensen's books have become best sellers to the business world and hence are influencing corporate strategies, academics are challenging his definition of what can be classified as a disruptive innovation, notably in distinguishing between an underperforming technology

from one that was inferior but eventually ended up as being disruptive (Danneels, 2004, Tellis, 2006). Christensen himself also recognized these criticism and that his theories still needed development (Christensen, 2006). These theories of disruptive innovation also work best when reflecting on change that has happened i.e. when a disruptive technology has been seen to change the business model of the organization or the organization has failed to meet the challenge. This *m-learning* research has occurred in the early days of such a transition and longer timescales would be needed to make judgments on whether higher education had succeeded in adapting to a mobile learning world. Nevertheless this is an important lens to consider in making a choice of theoretical model to frame this research.

The idea of disruptive innovations and the initial field study led the researcher to question further whether the Rogers model of diffusion is adequate to explain *m-learning* diffusion and the characteristics of the innovators involved. Rogers tends to categorise innovators as having a high degree of opinion leadership (Rogers, 2003) and whilst this will be true of many *m-learning* innovators, it doesn't explain all of them. In the initial field study (Chapter 4), examples emerged of tutors who simply wanted to improve the environment for their students and indeed some examples of student-led innovation. In many cases these innovators were working outside the normal system without the support of their universities and were 'establishing autonomy from organizational norms and rules' (Shane, 1994, p. 398). There is significant research on so called 'bootleg' innovators where researchers 'simply ignore management directives to embark on covert action in which they (themselves!) decide to invest company

resources and pursue innovation ideas' (Augsdorfer, 2005, p. 1). The innovation is neither in the departments' action plan nor is any formal resource allocated and is an 'outlaw innovation' (Flowers, 2008, p. 190). Initial field research uncovered at least two examples of innovation where it could be said to be covert. Another term applied is that of deviance in innovation where the innovation cannot be subject to the organization rules because it transgresses the established rules and standards before establishing a new social order (Alter, 2001). A potential focus of the field research would be to examine this further. There are some very significant organizational barriers that need to be overcome to propagate *m-learning* and it will be interesting to compare how much diffusion is supported through top-down management approved initiatives versus those that occur via more covert methods.

But what does the literature say about the concept of student innovation, which also yielded examples in initial field research? How does student innovation fit into the model? There are many studies into user innovation and these have been brought sharply into focus by open source software where groups of users have cooperated to create entire products (Lakhani and Von Hippel, 2003, Chesbrough, 2003). Some authors argue that innovation is being increasingly democratized such that users are increasingly able to innovate for themselves (Von Hippel, 2005). In analysing the characteristics of these innovating users, one common factor is that users innovate with the aim of some form of profit from developing a solution to their needs (Morrison et al., 2000). In the case of student *m-learning* innovation, it is not clear how the innovating user is rewarded other than by meeting his/her learning needs and possibly by recognition from

other students. In the two cases, discovered in initial field research, the idea gained momentum within the institution because the lecturer publicised it and indeed the lecturer took on the mantle of 'lead user' (Von Hippel, 1986, p. 791) and could be said to be rewarded by the ensuing publicity. This is perhaps another variation of the bootlegging approach above in that students and lecturers introduce the innovation by covert means and the various 'actors' in the institution are eventually recognised through a process of translation.

The literature review has thus far extracted key points from innovation diffusion applied to ICT in business. A university can be viewed as a business organization and indeed reductions in direct government funding is arguably transforming universities into highly entrepreneurial, customer focused and revenue seeking enterprises (Ackroyd and Ackroyd, 1999). However, the primary business of a university is to deliver education to its students and any investigation of *m-learning* cannot ignore its impact on pedagogy, although this will not be assessed in this thesis. The next paragraphs look at studies applying innovation diffusion to ICT in Education. Innovation diffusion has been widely applied to studies of new innovations in education. Factors which are likely to detract from development and integration of new technology into higher education include increased workload of the staff, lack of extrinsic incentives, lack of strategic planning, lack of training support and philosophical, epistemological and social objections (Newton, 2003). Often the enthusiasm of early adopters is mistakenly extrapolated to predict widespread adoption, only to find that diffusion patterns are inconsistent (Kirkup and Kirkwood, 2005). Technologies which can fit easily into current teaching practice are incorporated quickly as against those that may

radically change the way teaching and learning takes place such as e-learning and potentially *m-learning* (Kirkup and Kirkwood, 2005).

Other models have been used to look at diffusion of ICT in Education, notably 'concerns theory' which examines the concerns that different participants in an innovation diffusion process have as use of an innovation develops (Hall et al., 1987) and Activity Theory (Leont′ev and Hall, 1978, Engeström, 1987) which is used to identify contradictions between the users' needs and the institution's vision of how a new innovation would be used. These theories have much in common with Actor-Network Theory (Law and Hassard, 1999) in that they look at the innovation through the behaviour of the people using it in contrast to Rogers where the innovation itself is the focus. Hall and Hord's Concerns Based Adoption Model (CRAM) (Hall et al., 1987) has been widely used in looking at educational change and focuses on the role that people within an organization play in facilitating change. Their model can be used to examine people's differing concerns about technology depending on the stage they are at with their adoption. In the early stages people may want to know how an innovation will affect them whereas in the later stages they will want to know how to collaborate with others to maximise the innovation's potential. Using stages of concern and levels of use the model demonstrates the need for those introducing a new innovation, to be prepared to address the concerns of everybody involved and support people who are in different use levels. This concept is not dissimilar to Rogers' adopter categories and innovation attributes although the focus is on the individuals' attitudes to an innovation rather than the characteristics of the innovation itself.

Another widely-used model, which has some overlap with Rogers' adopter categories and innovation attributes, is the Technology Acceptance Model (TAM) which focuses on users' perceptions of an ICT innovation (Davis, 1989). This theory looks at factors that influence the perceived usefulness and ease of use of information technologies, placing emphasis on psychological and social influences. User perceptions will be a major factor in the embedding of *m-learning* and indeed much of the literature referred to in chapter 2 (which defines *m-learning* and reviews m-learning literature) makes the user behaviour a subject of pedagogical researchers. This will be a factor to examine when analysing results of any field research but it should be noted that the main aim of this study is organisational receptiveness as opposed to user behaviour.

The ideas behind concerns based theory and the focus of the technology acceptance model are a reminder that users may not rush into using *m-learning* technologies and reinforces the evidence from the diffusion literature that time is a significant factor and that rates of adoption vary widely between individuals and situations. This also brings to mind the 'Assimilation Gap' where organizations take time to absorb an innovation before trying to deploy it (Fichman and Kemerer, 1999). This is evidence suggesting that in order to study *m-learning* embedding in detail a temporal dimension will be required, looking at university deployment over a period of time.

In more specific instructional technology research, Ely (Ely, 1990) describes eight conditions that facilitate implementation of the technology-based change

process in an educational setting: dissatisfaction with the status quo, existence of knowledge and skills, availability of resources, availability of time, existence of rewards or incentives, participation, commitment, and leadership. This model again overlaps with Rogers' innovation attributes and key points that emerged from the literature review of innovation diffusion research into ICT. This use of other models perhaps underlines a potential shortfall in Rogers' diffusion model when it comes to looking at an organization delivering education. Much of Rogers' research focuses on industrial organizations implementing innovations where the individuals work together to 'achieve common goals' (Rogers, 2003, p. 433). Considering ICT innovations, although early adopters might be fairly autonomous in their decision making, once a company sees the benefits, they are likely to make a collective decision to adopt and make the innovation a necessary part of the working process (Rogers, 2003). In education establishments, such as universities with independent faculties, collective decision-making is harder to implement as individuals have much more autonomy within their workspace. Attempts to centralize control and impose decisions from the centre can result in academics exhibiting low levels of commitment to their institutions and resistance to change (Winter et al., 2000).

These education focused innovation theories and models have been used and developed in an attempt to build an innovation diffusion model for integrating instructional technology into education (Surry et al., 2005). This model derived from Rogers, Hall & Hord and Ely's work (Rogers, 2003, Hall et al., 1987, Ely, 1990) has elements based on Resources, Infrastructure, People, Policies, Learning strategies, Evaluation and Support (abbreviated as RIPPLES) as factors

(Surry et al., 2005). The model remains largely untested and early work has been based on questionnaires completed by Deans of Education in US universities. The rather surprising conclusion from the survey that a 'colleges technology infrastructure is the single most important factor in integrating technology into the curriculum' (Surry et al., 2005, p. 328) goes against the common findings of most IS implementations in that it is 'soft' factors such as people's perceptions and attitudes which determine the success or otherwise of a project (Checkland and Holwell, 1998). It is relatively easy to create infrastructure but much harder to encourage a team of people to use that infrastructure to its true potential and most recent work on Information Systems has seen the impact of technology on organizations not to be determined by functionality but as a product of the peoples' 'shared interpretations or interventions' (Orlikowski, 1992, p. 400). Having only gathered data based on the opinions of faculty deans, the authors readily admit that the model can only be verified by applying it in a real technology introduction scenario (Surry et al., 2005).

A study of innovation diffusion of computer technology in schools, recognises the concept of 'social capital' where the effects of social pressure and ready access to informal expertise were highly significant in determining the success or otherwise of an innovation (Frank et al., 2004). Members of an organization derive benefits from that organization which include social and psychological rewards and access to resources, information and status. In spreading an innovation they can exert some social pressure on each other to support the innovation through coordination, access to resources and shared desire to protect their positions (Ibarra, 1993). The concept of social pressure is akin to the

findings in Karahanna et al's study on IT diffusion which show that social beliefs are the strongest factor in post-adoption attitudes where the impact of using an innovation on the individuals' status and image is paramount in their decision making (Karahanna et al., 1999) Furthermore, members of an organization can share a common fate in terms of the success or otherwise of that organization. They are more likely to help other members of the organization support and adopt an innovation if it improves their common fate (Frank et al., 2004), albeit that this study was applied to innovation in schools and applies to staff rather than students. Will staff in universities show the same tendencies as those in schools given the independence of faculties and the independence of subject groups within faculties (See Section 3.3 for discussion on research questions)?

The points about innovation in schools relate to staff adoption but what is the impact of social capital on student adoption of technology? There is also a link here to the technology acceptance model (Davis, 1989). Image and social influence that arise from using an ICT innovation are factors which encourage users to have increased perceptions of usefulness of that innovation (Venkatesh and Davis, 2000). The concept of social capital and the image that arises from feeling part of a group is a major factor in developments of recent social networking technologies such as Facebook and Twitter (Ellison et al., 2007). These findings strongly suggest that social capital will be a factor in the embedding of *m-learning*, particularly when students are already regularly using social networking technologies on their smartphones (Ofcom, 2012).

Many studies have found that new technology has the potential to cause some level of organization change which in some cases (e.g. the internet and book selling) can radically re-engineer how an organization operates (Brown and Duguid, 2002). Instructional technologies such as *m-learning* can challenge established ways of teaching and learning, and thus the potential users will question what Rogers terms as its compatibility and whether 'it is consistent with existing values, past experiences and needs of potential adopters' (Rogers, 2003, p. 240). Instructional technology has the power to be highly disruptive to the way in which university courses are delivered and raises fundamental questions about how people learn and teach, the culture of the educational institution itself and how students are monitored and assessed (Szabo and Sobon, 2003). The disruptive nature of the technology can lead to resistance to change existing teaching and learning methods and the large investment in human resources militates against disruptive changes that threaten to reduce the effort required to deliver courses to students (Hughes, 2001). Also the university environment may discourage risk-taking when the culture penalises those who make mistakes (Christensen and Eyring, 2011). Nobody wants to be seen introducing a significant IS investment which fails to get utilised and is eventually discarded. In investigating *m-learning* diffusion, it will be interesting to see whether fear of change and aversion to risk are significant factors in delaying adoption.

But if an innovation can be introduced and successfully trialled, can it be embedded? It is certainly not easy to show that an instructional technology has improved student performance and evidence of this might not emerge for some time or be difficult to separate and measure from other factors such as teacher

and student cohort capability (Middleton and Murray, 1999). Often an investment in new instructional technology may be due to some external funding and so the evidence of student performance may not emerge during the funded project. It would be necessary to look at intermediate outcomes to be able to measure some impact such as feedback from students and staff on their experience (Sherry et al., 2002). In another study, nine factors that engender the embedding of an educational innovation are identified as strong leadership, strong infrastructure, support and training, incentives, visibility of the project, credibility, mutual partnerships, macro culture development and lastly, sufficient funding (Billig, 2002). Most of these are common to Rogers' diffusion characteristics and attributes such as relative advantage and compatibility. However Billig's model also identifies some additional points such as the visibility of a new initiative and credibility in terms of demonstrating success. It is not uncommon for projects within educational institutions to remain the knowledge of a few innovators and early adopters and it will be interesting to see if *m-learning* initiatives are publicised within a faculty and university or whether they are localised and lack visibility perhaps due to a fear of public failure. Will the absence or presence of visibility be a factor in *m-learning* diffusion? Billig's studies also discuss the role of incentives in ensuring innovations embed. In terms of those delivering the courses, professional development, new technology and more efficient ways of working may be rewards (Billig et al., 2005) but what about the receivers of this new initiative? Many new initiatives have an early burst of enthusiasm and then die away. How will students be incentivised to utilise these new technologies? Will it be through mandatory participation in course activities, the appeal of the new technology, savings in effort or even

financial incentives through reduced costs of learning? So, how will *m-learning* adopters be incentivised to maintain their usage and what will be the 'commodity or object that is desired by the recipient' (Rogers, 2003, p. 23) that ensures successful adoption? Will there be consistent features in these incentives or will they be institution specific?

Another consideration is the complexity of the technology in terms of both administration and usage. Rogers argues that the easier an innovation is to use, the more likely it is that it will be adopted; 'complexity of an innovation…is negatively related to its rate of adoption' (Rogers, 2003, p. 257). Mobile and wireless technologies can be seen as complex and difficult to use, at least until recent technologies such as iPhone and Android phones, made them appealing or even addictive to a wider marketplace (Oulasvirta et al., 2012) . However, the intended audience for *m-learning* is students whose population is dominated by an 18-25 age demographic whose exposure to technology is significant with examples of sophisticated usage of PCs, PDAs, MP3 players, tablet computers and smartphones (Johnson et. al., 2013). So it could be argued that complexity in this case may not be as great a barrier to adoption as the audience may be more receptive to those complexities, although the complexity might prove a problem for lecturers who are less comfortable with mobile devices. A study of broadband-enabled learning in Canada showed that a complex learning environment could gain widespread adoption if it is well supported (Murphy, 2005). If the support can foster capacity-building in participants then they should be able to 'eventually manage the use of the technology independently' (Murphy, 2005, p. 535) and the technology crosses the 'chasm' between a trial and a

solution and becomes established (Moore, 2002). Thus high-levels of complexity may not pose a threat to adoption and this will be a factor to examine in this research. However, it would be risky to generalise from one project as Murphy's study does above. Complexity is nearly always a barrier to ICT adoption (Davis, 1989) and Rogers' statement that 'complexity of an innovation…is negatively related to its rate of adoption' (Rogers, 2003, p. 257) would appear to dominate.

Reviewing the literature, there appears to be no shared perspective of examining strategies for introducing information systems into education. There are somewhat pro and anti research groups within ICT in Education – those who see new technology as an educational messiah and those who see it as a danger that will encourage the death of humanistic teaching traditions (Oppenheimer, 2003). There is little common ground between the disparate perspectives involved and thus this may 'preclude the successful search for integrative theoretical frameworks' (Seely, 2009, p. 7). ICT in Education is still a new topic with 'theory that is in its relative infancy' (Gardner and Galanouli, 2004, p. 152). There is also the problem that education is subject to ever-changing policy and practice which has led to research which tries to measure the effects of this in timescales which preclude more rigorous scientific research (Hammersley, 1997). What is agreed is that there is no integrated theoretical framework for understanding the impact of technology on higher education (Underwood, 2004). And when *m-learning* is considered, pedagogy researchers are still searching for an agreed theory of learning too (Sharples et al., 2007).

3.3 Using Actor-Network Theory and not Diffusion theory

The review of diffusion theory helps identify factors to use in determining the enquiries which can be investigated to see how and why *m-learning* might be different than just another IS innovation. However, there is criticism of the use of diffusion in IS Research, notably that of Wastell and McMaster (McMaster and Wastell, 2005). The placing of an innovation at the centre of the theory tends to lead to research which assumes the innovation is in some privileged position and the theory may be prejudiced against those that may reject the innovation for reasons that are not necessarily objective or based on technology capability. Little attention might be given to more hidden motives – 'the political agenda within the status quo remains neither problematized nor questioned' (McMaster and Wastell, 2005, p. 396).

Actor-Network Theory has gained popularity as an IS research approach, particularly in looking at situations where technology is an agent of change. Studies include work by Walsham, McMaster and others (McMaster et al., 1999, Walsham and Sahay, 1999). There are also a number of articles that compare different theories used to investigate technical innovations, notably comparisons between ANT and Activity Theory (Miettinen, 1999) and ANT and structuration theory (Jones and Karsten, 2008). Activity Theory is extremely popular in the education world and has been widely applied to *m-learning*, notably in the work of Mike Sharples (Sharples et al., 2007). As a theory it is well positioned to look at learning solutions, breaking down learning tasks into a series of activities.

Supporters of Activity Theory who are critical of ANT point to problems of 'generalized symmetry' (Miettinen, 1999, p. 181). By symmetry they refer to the

importance placed in ANT on treating non-human actors as equal partners in the network. It is claimed that this can give innovations a dominant role in the analysis and perhaps marginalize the role of the human actors such as software engineers or end-users. In effect, one could view this problem in a similar way to the criticism of diffusion, placing too much emphasis on the power of the innovation or the role of the innovator. However ANT makes no demand to place the technical artefact at the centre of the analysis but simply suggests that the researcher should 'follow the actors' (Latour, 2005, p. 227) to gain the necessary insights. Following a non-human actor or technical artefact is a process of looking into the interactions of the artefact with the human actors which would surely avoid placing too great a priority to the innovation. Spinuzzi's (Spinuzzi, 2008) study of developing knowledge networks in US telecommunications organizations uses both ANT and Activity Theory to look at how a telecommunication service provider works. He concludes that Activity Theory is better suited to looking at networks of learning and learning activities (a view clearly shared by many *m-learning* researchers such as Sharples (Sharples et. al, 2007) and Traxler (Traxler, 2007)) but that it had weaknesses in looking at links between networks, 'the boundary objects' (Spinuzzi, 2008, p. 206). Spinuzzi felt that Activity Theory placed too much emphasis on development tasks, with not enough focus on the interactions between those tasks. As this research had a goal of looking at how *m-learning* projects became linked to overall university strategy then links or boundary objects were a key focus and hence Activity Theory was not chosen.

What of structuration theory which has also been frequently used in analysing IS projects? Giddens' structuration theory (Giddens, 1984) looks at the relationship between individuals and society rejecting the view that social phenomena are determined either by social structures or autonomous human action. Giddens proposes that social phenomena are the product of both social structure and human agency – people draw on social structure to determine their actions and in turn these actions produce and modify social structure. Structuration theory focuses on the agency of humans and does not include the concept of agency in objects, unlike ANT, although it does recognize the ability of technology to influence social structures. Structuration theory is seen as' bypassing the structure/agency debate' (Jones and Karsten, 2008, p. 146) as it represents a modernist view that ANT rejects (Latour, 1993b).

Structuration theory may be more helpful in examining technologies that are more established through repeated cycles of implementation and use, and where apparent order is made and re-made. The *m-learning* projects examined in this thesis were not at that stage. There seemed to be more potential to make a contribution using ANT's concepts of translation and the existence of links between networks. The notion of boundary objects (Star and Griesmer, 1989) also seemed to represent an opportunity to look at how these early projects might build links into the common IS strategy for an institution- in effect a path to embedding.

The issues identified with *m-learning* can be best described by the diagram below. The diagram (Figure 3) shows that innovation can be initiated from a

number of sources – lecturers and students as individuals, funded projects or even as conscious investments in pilot services by the university itself. In order to thrive and embed, these smaller networks of actors experimenting with *m-learning* need to engage with the institution on a wider level unless they are completely self-sufficient. There exists a range of institutional actors with which an *m-learning* project must engage in order to embed and these could include policies, departments, committees, funders (both internal and external) or even powerful individuals within the senior management who may need to be in enrolled in some form of translation in order to implement *m-learning* that will embed.

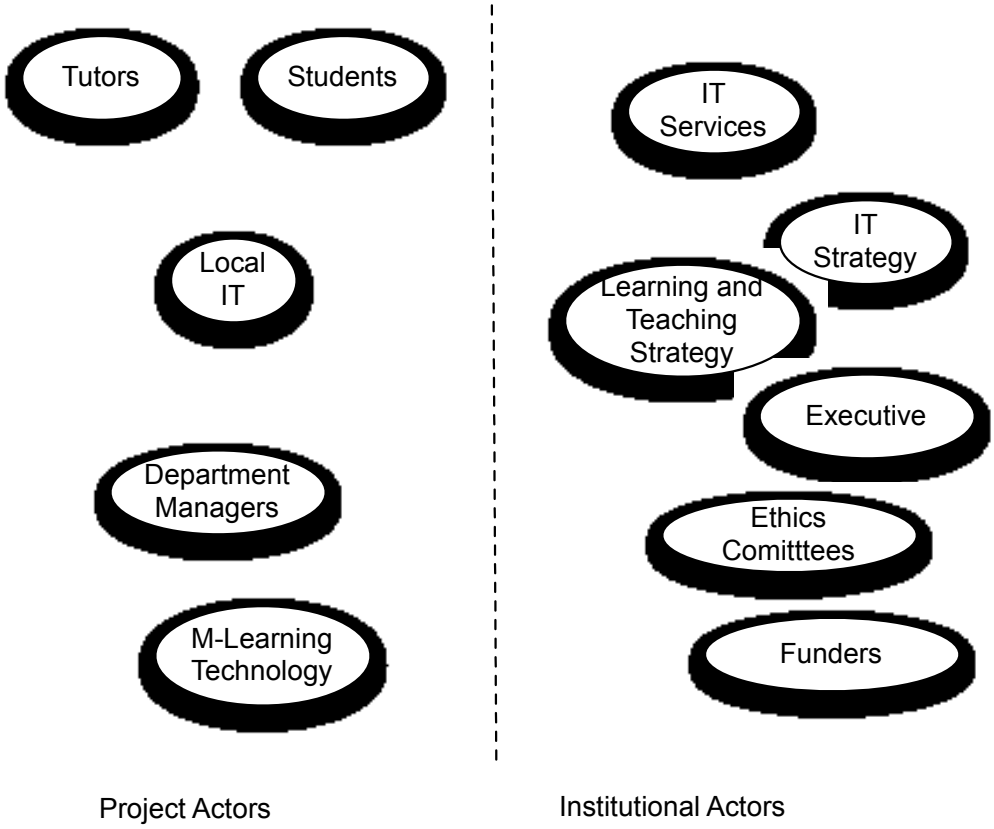

Figure 3 – Innovation Barriers and Enablers

If *m-learning* is considered a potentially disruptive innovation then, in order for it to succeed, the range of departments, staff and policies positioned in the diagram above will need to undergo change before it becomes an irreversible feature of the university environment. In Actor-Network Theory terms, these are all actors in a network and will have to undergo a set of translations. 'Mediators and intermediaries' must form relationships so that the processes and departments above translate into a network (Latour, 2005, p. 40). If the technology is to become established then the actors must undergo irreversible change (Callon, 1991) and that degree of irreversibility will depend on whether it remains an isolated example or whether it embeds and starts 'to shape and determine subsequent translations' (Callon, 1991, p. 159).

Whilst Actor-Network Theory and its notions of networks and translations would seem to lend itself well as a method of looking at how these barriers are overcome, another part of ANT is even more promising. Looking at project failure in the aircraft manufacturing industry, Law and Callon proposed the concept of local and global networks and the boundaries between the two (Law and Callon, 1992). They identified three factors which influenced the success or failure of a project with the most significant being 'the capacity of the project to build and maintain a global network which will for a time provide resources of various kinds in the expectation of an ultimate return' (Law and Callon, 1992, p. 46). They also talk about points of passage between the two networks which again looks like a concept that would help bridge the dotted line in Figure 3 above. The effectiveness of points of passage could be a key issue in the

embedding of *m-learning*, a concept that also appears as 'boundary objects' (Star and Griesmer, 1989, p. 388) in an earlier ANT-based study.

A simple instance of a 'local network' in *m-learning* could be for a student to innovate, a lecturer to support the innovation and their interaction to form a local network where the students and lecturers cooperate. A good example is using text messaging of questions in lectures, something which in isolation does not require other actors in the university to approve or participate in. But this process eventually interacts with the global network as the practice spreads to other lecturers/faculties and teaching and ethics committees and perhaps unions start to debate whether this is acceptable practice or whether there are student inclusion issues and the requirement to form an institution-wide policy emerges. Therefore significant factors will be the ability of the local network to build links with the global network and influence the global network to approve and support the innovation and develop institutional policies to support it. Actors, be they individuals or even artefacts, need to become points of passage between the two networks for that influence and support to be achieved. In addition, a further strength of this local/global network model is the temporal aspect in that it looks at project trajectories and our interest is the shifting focus, actors and fortunes of a project over time rather than the identification of a specific moment of translation.

Having reviewed the ANT literature and identified the local/global model as a way forward, it is useful again to reflect on the meaning of the term embedding within the context of this research. The researcher's tacit knowledge gives a

strong indication through prior experience that examining the strength of the links between a trial or pilot project and overall organization strategy would be a key area to explore in the field research. The Law/Callon model of the local/global network appears to offer the opportunity to explore those links. In effect, embedding can be defined in the context of this research as evidence that findings from local projects are influencing global IT strategy. The existence and effectiveness of points of passage between the networks will be a focus for subsequent field research.

3.4 Chapter Summary and Contribution to Knowledge

To see whether this aspect of ANT could give unique insights, it is imperative to look at whether Law and Callon's local/global concept (Law and Callon, 1992) has been utilised in IS research. Most prominent is a paper from Heeks and Stanforth (Heeks and Stanforth, 2007), which uses the local/global framework to analyse the trajectory of an e-government project. They comment that the local/global network framework 'seems to have been little used to date' (Heeks and Stanforth, 2007, p. 166). The only other identified IS research using this framework is from Gasson (Gasson, 2006) where it forms one small sub-component which is separate from the main theme of her research. The only other IS paper referencing this looks at ERP systems but doesn't actually use the framework in its approach and findings (Elbanna, 2007). Law and Callon's local/global framework engages with actor/network concepts and is relatively accessible in its application but can deal with the complexities of a multi-stakeholder project trajectory (Heeks and Stanforth, 2007).

This local/global network model looks to be a good fit to studying the trajectory of an *m-learning* project and its links to the university organization. Using Law and Callon's framework (Law and Callon, 1992) also clearly presents an opportunity for this research project to make its unique contribution to knowledge for the following reasons:

1. The Heeks and Stanforth paper (Heeks and Stanforth, 2007) looks at a top-down e-government project rather than a potentially disruptive locally introduced innovation like *m-learning*. E-government is a centrally mandated concept whereas *m-learning* is not (at the time of this research) being introduced by top-level management initiatives. Rather it is being introduced in a bottom-up fashion through a combination of externally funded pilot projects, local faculty initiatives or indeed via entrepreneurial staff and students. This application of the Law/Callon framework to *m-learning* will be a clear extension of the use of actor-network theory in the IS area and thus a new contribution to understanding the embedding of IS innovations.
2. Literature searches and the work of Heeks and Stanforth confirm the low utilisation of Law and Callon's framework in the IS field. With only two previous examples of the use of local/global framework in the IS field, the opportunity for new insights is significant (Heeks and Stanforth, 2007).

With the potential contribution to theory identified, the next challenge would be to look at the research design and methodology. However it is useful to summarise some of the key issues that the literature review has identified, as this

will aid the development of potential enquiries that can be made in the field research. The literature review has shown that there are many potential factors which could affect the embedding of *m-learning* in university environments. Drawing on *m-learning*, innovation diffusion theory and studies of Information Technology diffusion and diffusion of ICT in Education, important high-level factors in the research would appear to be links into the organization, executive and strategy, and links between *m-learning* projects and the IS, learning and teaching strategies of the institution, the appeal of the technology to the users (both staff and students) and the receptiveness of a university to embrace new and potentially disruptive learning technologies. The review of innovation literature together with the review of *m-learning* specific literature described in Chapter 2, has produced many possible research questions that are summarised in a table below (Table 1) together with a category and the relevant literature references. These questions will influence the field research although not all of them proved relevant in practice. For example some of the potential issues identified in the literature may not occur in practice or may prove impractical to observe given the choice of specific case studies that are introduced in Chapter 5 which describes the research methodology. For this reason, the table also contains a column that is either a forward reference to where the question is evidenced and discussed in the field research chapters (Chapter, 6, 7, 8) and concluding chapters (Chapter 9,10) or indicates that the question was not possible to evaluate.

The questions are divided into four broad categories of issue: those involving *m-learning* specifically, information systems in general, teaching and learning and

finally those that arise from the general innovation diffusion theories of Rogers, Christensen and others (Rogers, 2003, Christensen, 1997) that have the potential to affect the whole university in terms of its strategy, business model and organization structure.

Question Number	Possible Research Question	Category	Related literature	Example
1	Limitations of devices and networks?	MOBILE LEARNING	(Kukulska-Hulme, 2005, Ryu and Parsons, 2009)	See example in Project MED Section 7.3.2 on Engagement where slower devices impacted students.
2	Student's own device or university supplied device?	MOBILE LEARNING	(Traxler and Riordan, 2004, Johnson and Brown, 2012)	See Section 9.1 discussion on business model for summary of findings
3	Invasion of students' personal space by interacting with their device?	MOBILE LEARNING	(Traxler, 2010)	See Section 6.3 on Communication in Project SMS for ethical issues relating to text messages to student phones
4	Disruptive in a teaching and learning environment?	MOBILE LEARNING	(Sharples, 2002, Selwyn, 2009)	See Section 7.3.2 on Technical Issues for example of disruption fears in a clinical environment. And Section 9.2 for summary of findings
5	Conflict between *m-learning* and the university strategy and business model?	MOBILE LEARNING	(Kukulska-Hulme and Traxler, 2005, Traxler, 2010a)	See discussion on Fragmented IT Strategy in Section 9.1 and Section 6.3 on links to IT strategy for Project SMS
6	Will students naturally adopt *m-learning* as they are familiar with the technology and its use?	MOBILE LEARNING	(Prensky, 2001, White & Le Cornu, 2011, Beetham et.al, 2009)	See discussion on Engagement in Section 7.3.2 for Project MED
7	Are *m-learning* technologies easy to use and fit in with users expectations?	INFORMATION SYSTEMS	(Rogers, 2003, Cooper and Zmud, 1993)	See discussion on Engagement in Section 7.3.2 for Project MED
8	Are services closely linked to the needs of the users?	INFORMATION SYSTEMS	(Malhotra and Segars, 2005)	See discussion on multiple service offerings in Section 9.1

Question Number	Possible Research Question	Category	Related literature	Example
9	Are organizations who have purchased *m-learning* technology deploying it or is it shelfware?	INFORMATION SYSTEMS	(Fichman and Kemerer, 1999, Glass, 1999)	Not tested within the case studies used.
10	Do high-levels of complexity pose a threat to adoption?	INFORMATION SYSTEMS	(Murphy, 2005, Rogers, 2003, Moore, 2002, Davis, 1989)	Example in Project MED of complex device setup issues. See discussion on Engagement in Section 7.3.2 and Technical Issues in Section 7.3.2
11	Is there a social impact on the students and academic staff in terms of changing the way they learn and work?	TEACHING AND LEARNING	(Kukulska-Hulme and Traxler, 2005, Hughes, 2001, Szabo and Sobon, 2003)	Not evidenced widely in the field research. Some examples in Project MED – see Section 8.1.3 on University A medical students with iPhone apps helping them in wards
12	Will staff 'steer' student adoption or could the inverse be true, students may 'pull' staff adoption in response to student needs?	TEACHING AND LEARNING	(Karahanna et al., 1999, Redmond, 2003)	Not tested within case studies, as projects were staff led. Some evidence of student pull in Project SMS – Student Union setting up NOSHOW service (Section 6.4.3)
13	How will students be incentivised to utilize these new technologies? Will it be through mandatory participation in course activities, technology appeal, effort savings or financial through reduced costs of learning? Generic or institution specific?	TEACHING AND LEARNING	(Newton, 2003, Ely, 1990, Billig et al., 2005, Rogers, 2003)	Not a factor in case studies so not tested. Activities were not mandatory hence low student take-up in Project MED (see Section 7.3.2).

Question Number	Possible Research Question	Category	Related literature	Example
14	Will the potentially disruptive nature of the technology on existing teaching methods encounter major resistance to change or will it be seen as a complementary tool?	TEACHING AND LEARNING	(Kirkup and Kirkwood, 2005)	Not a major factor in case studies. Some evidence of disruption of teaching methods in hospitals who were suspicious of devices. See Section 7.3.2 on technical issues.
15	Does a disruptive technology *like m-learning* fit traditional theories of new technology adoption in higher education?	INNOVATION AND UNIVERSITY STRATEGY	(Rogers, 2003, Lettl et al., 2006, Afuah, 1998, Christensen, 1997)	See revised Law/Callon model in Chapter 10 and comparison with innovation theories in Section 10.3
16	What are the benefits of the technology and how do they fit into the institution's strategy?	INNOVATION AND UNIVERSITY STRATEGY	(Rogers, 2003, Cooper and Zmud, 1993)	See discussion on Demonstrating Value in Section 7.3.2
17	Since many initial *m-learning* projects are funded through short-term research grants, do they remain as research activities or do they diffuse into the wider environment?	INNOVATION AND UNIVERSITY STRATEGY	(Rogers, 2003, Hall et al., 1987)	See conclusions on embedding in Project MED Section 8.6 and Table 14 for summary of embedding strategies of different institutions.
18	Are there important differences identifiable between universities that successfully embrace and implement *m-learning* and those that are unable to 'translate' irreversibly?	INNOVATION AND UNIVERSITY STRATEGY	(Latour, 2005)	See Table 17 in Chapter 10 to show differences between institutions. Using revised Law/Callon model
19	What is the effect of 'points of passage' or 'boundary objects' on the embedding of an innovation?	INNOVATION AND UNIVERSITY STRATEGY	(Law and Callon, 1992, Star and Griesmer, 1989)	See discussion in Section 10.2 for examples of points of passage.

Question Number	Possible Research Question	Category	Related literature	Example
20	Does *m-learning* have a niche deployment rather than widespread diffusion across all faculties and universities?	INNOVATION AND UNIVERSITY STRATEGY	(Grover and Goslar, 1993, Gurbuxani, 1990)	See 8.6 for summary of state of embedding in the institutions researched and section 10.5 for future studies
21	Are universities with geographically dispersed campuses more likely to embrace the *m-learning* technology than those located on one site?	INNOVATION AND UNIVERSITY STRATEGY	(Wolcott et al., 2001)	Did not occur in institutions that were researched.
22	Will universities which have good networking across faculties, especially by those with expertise in instructional technologies, also prove a significant factor? And what about networking between institutions to share experience?	INNOVATION AND UNIVERSITY STRATEGY	(Rogers, 2003, Swan et al., 1999, Pittaway et al., 2004)	Examples of good networking between institutions in Project MED (See Section 7.1) and good networking within institutions (University B and C, Sections 8.2 and 8.3) and less effective networking within other institutions (University A Section 8.1) and in Project SMS (Section 6.5)
23	Does the independence of departments and faculties act as a barrier to a central coordinated *m-learning* strategy?	INNOVATION AND UNIVERSITY STRATEGY	(Rogers, 2003, Christensen and Eyring, 2011, Winter et al., 2000)	See Discussion on Fragmentation of IT Strategy (Examples University A and E Sections 8.1 and 8.5) and 9.1
24	Impact of central vs. distributed decision making?	INNOVATION AND UNIVERSITY STRATEGY	(Allen et al., 2002, Burns and Stalker, 1961, Pervan et al., 2005, Grover and Goslar, 1993)	See Discussion on Fragmentation of IT Strategy (Examples University A and E Sections 8.1 and 8.5) and 9.1
25	Are fear of change and aversion to risk, significant factors in delaying adoption	INNOVATION AND UNIVERSITY STRATEGY	(Redmond 2003, Frank et. Al, 2004, Hughes, 2001, Christensen and Eyring, 2011)	Did not emerge in the field research as a significant factor.

Question Number	Possible Research Question	Category	Related literature	Example
26	Will staff see *m-learning* as cost-saving strategy by an institution and resist its use?	INNOVATION AND UNIVERSITY STRATEGY	(Braverman, 1974, Tinker, 2002, Redmond, 2003)	Did not emerge in the field research as a significant factor.
27	What is the impact of organizational politics on *m-learning* embedding?	INNOVATION AND UNIVERSITY STRATEGY	(Cooper and Zmud, 1993, Jones and Stevens, 1999)	Some evidence in field research. See NOSHOW discussion (Section 6.4.3) in Project SMS.
28	Are *m-learning* initiatives publicised within a faculty and university or are they localised and lack visibility perhaps due to fear of public failure? Is visibility a factor?	INNOVATION AND UNIVERSITY STRATEGY	(Billig, 2002)	See Chapter 6 Project SMS where lack of visibility leads to competing translations. Lack of visibility in University A leading to embedding within a faculty but lack of support from central IT (University A, Section 8.1)
29	What impact do social pressures and social capital have on staff and students in adopting *m-learning* technologies?	INNOVATION AND UNIVERSITY STRATEGY	(Venkatesh and Davis, 2000, Frank et al., 2004, Ibarra, 1993, Karahanna et al., 1999)	Not evidenced in field research.
30	Impact of maverick innovative staff or student innovation in *m-learning*?	INNOVATION AND UNIVERSITY STRATEGY	(Augsdorfer, 2005, Chesbrough, 2003, Shane, 1994, Von Hippel, 2005)	Not a focus of field research. See Section 5.5 on case study sample for discussion.
31	What factors will maintain the embedding of *m-learning* after its initial introduction into a university?	INNOVATION AND UNIVERSITY STRATEGY	(Rogers, 2003, Sherry et al., 2002, Billig et al., 2005)	Main issues are described in Section 9.1 and in Chapter 10 on points of passage (See Section 10.2)

Table 1 – Possible Research Questions

Clearly to investigate all of these questions thoroughly is too large a task so this research focuses on the issue of looking at how embedding of *m-learning* can be

modelled in ANT terms and what contributions to theory and practice arise from this. The above questions (Table 1) are included to summarise the main points from the literature review and provide a forward reference to where they are discussed in the research results. They are the basis for the design of the detailed research methodology (See Section 5.8).

The main aim of the research is to apply the Law/Callon model as a theoretical lens to the process of the embedding of *m-learning* and to answer the main research question:

> How do university organizations (business models, modes of operation, people and processes) adapt to a potentially disruptive innovation like m-learning and what factors and working practices support or hinder embedding?

The main contributions can be summarized in the following three areas:

- **Contribution to Theory**. This PhD will apply Law and Callon's local/global framework aspect of Actor-Network Theory to a bottom-up initiated IS project in order to analyse the impact and embedding of potentially disruptive IS innovations on university organizations (See Chapter 10 for the outcome which includes an extended model, the major contribution of this thesis)
- **Contribution to *m-learning***. The use of mobile devices in a university environment is not widely covered from a business information systems

perspective in the literature so a contribution to knowledge is made through a detailed study of two *m-learning projects* with a summary of the major embedding issues that occurred (See Section 9.1).

- **Contribution to Practice**. The extended Law/Callon model and the *m-learning* embedding issues identified have potential practical usage (See Section 10.4).

This chapter has examined the meaning of the term embedding, namely the existence and effectiveness of a process to capture the outputs of an *m-learning* project within the institutional ICT strategy. It has also identified a theoretical lens in which to investigate this process, namely Actor-Network Theory. The next chapter will look at the initial field study which was used to determine the most appropriate areas of inquiry before considering the methodology best suited towards a deeper look into *m-learning* projects (See Chapter 5).

4. The Initial Field Study

In conducting the literature review (Chapters 2 and 3), the research was aided by having conducted some early fieldwork that effectively acted as a market research exercise, helping to focus the literature searches to generate an informed set of potential research questions (See Table 1). This initial field study took place in 2006/2007 and involved face-to-face interviews at ten different UK universities. A mixture of institutions was selected for the sample which included universities in cities, newer campus-based universities and a mixture of both post-1992 institutions and more traditional Russell Group members. The interview subjects were involved in *m-learning* either because they were internationally known experts/researchers on the subject or they had a leading role in introducing forms of *m-learning* into their institution. Mostly these people could be described in Rogers' terms as innovators in their own environment, researching and trying to implement new learning technologies in their institution. It is clear that the mobile technology landscape has changed considerably since 2007 when devices such as the iPhone and iPad were not on the market, 3G network speeds were not widely available and the number of users with smartphones was considerably less than would exist in todays' marketplace. This can be compared to the situation in 2012 when 40% of UK adults are using smartphones and access to the internet by mobile device has quadrupled from 2007 levels (Ofcom, 2012). However many of the issues that they identified are still relevant.

The findings were consistent across the interviews with most respondents reporting the same issues that they were experiencing or expected to experience. These are mostly in the form of barriers to establishing and embedding an *m-learning* innovation in a university organization. Issues which dominate are skills gaps (both in students, IT support and especially academic staff), lack of technical support (IT services provision), Procurement and accounting policies which are based around PC usage, Inclusion issues, Ethical and legal issues, Quality assurance, Financial resources (all projects are based on external funding), Device limitations, Standards Churn, Privacy and Security and Lack of a 'killer application'. It is worth noting that the respondents themselves would be eager to point out that the views expressed are their own and they are not acting as an official spokesperson for their institution. However, none of the institutions at the time of this research had an *m-learning* strategy or indeed any official contact point on this subject. The situation is typified by one comment: 'I took my mobile learning project to the head of IT strategy and asked if I fitted in to the institution's strategy and "you are the strategy" was the immediate reply'. Now the gulf between *m-learning* and institutional IT strategy has considerably narrowed since 2007 with widespread recognition that services such as podcasting, text messaging and access to student portals via smartphones, are becoming core services which a student would expect to be present. This thesis will investigate the extent of a gap between mobile learning projects and overall IT strategy and in ANT terms, whether effective points of passage exist between the institution and individual *m-learning* projects (See Chapter 10 for the conclusion).

The table below (Table 2) shows the density of findings from the 2006/2007 interviews:

Issue Raised	**Density of finding (No of interviews)**
Lack of IT Services support	10
Skills Gap	9
Finance of projects	9
Quality Assurance	8
Procurement and accounting issues	7
Mode of Learning	7
Ethical and Legal Issues	6
Software and Integration	6
Flexibility & Work-Life Balance	6
Disruption	6
Data Ownership	5
Cost of Downloads	3
Lack of Business Model	3
Lack of killer application	2

Table 2 – Density of interview findings

Having found evidence of a disruptive innovation with diverse innovators (both lecturers and students) how did this align with the theoretical context derived from the literature?

4.1 Innovation Diffusion

Having identified many barriers to adoption, it seems unlikely *m-learning* will follow the traditional Rogers S curve pattern. There are some major potential mismatches between the technology, the skills of the people involved and the way that the organization (university) is structured. In 2007 there was little evidence that universities were investing their own money in *m-learning* technologies (apart from some implementations of podcasting) so the activity is taking place in funded research projects and thus can exist outside of the influence of these potential barriers such as IT services and finance. In ANT terms, none of these 'actors' has been subject to any form of translation as the projects have been conducted as research activities. Evidence that the projects can translate into mainstream institutional offerings was not promising with IT Services in nine of the ten interviews reluctant to get involved. Typically *m-learning* was not seen as a core service and thus undeserving of centralised IT services resources. There was evidence of investment in podcasting software by several universities, but podcasting itself is not profoundly incompatible as it is simply an additional service rather than a challenge to the current IT provision. However, there were and continued to be, signs of problems involving lack of skills and integration of podcasting (where the infrastructure was largely Apple based) with existing institutional Microsoft dominated IT infrastructure

In most cases the *m-learnin*g innovation has come from staff engaged in research wanting to try out ideas. But there are examples where the innovation was student-led such as requests for podcasting and the use of text messaging to ask questions in lectures. There is also the issue of skills where respondents felt that

these are out-of-sync in terms of student IT skills improving and staff skills not improving at the same rate particularly with the ageing demographic of academics (Kinman et al., 2006). Respondents felt that this may be exacerbated as students start to enter universities with knowledge of *m-learning* acquired through a combination of experience in primary and secondary education and developments in social networking, envisaging a 'digital natives versus digital immigrants' relationship between staff and students (Prensky, 2001) . The emergence of student innovation in the findings is a very interesting phenomenon to study further where the innovation is coming from both sides (but perhaps increasingly from students) with the university's resource allocation mechanisms such as IT and finance positioned in between as a barrier. However that is another potential research area; the focus of this thesis will be the embedding of *m-learning* projects that are initiated by staff innovation and through funded research projects.

4.2 The benefits of the technology and how they "translate" into the institution's strategy

Respondents felt that there were clear benefits in the technology with many examples. In science and medicine, students out in the field can take electronic notebooks to help them record information or call up information to help them assess situations (e.g. trainee doctors having anatomical information on PDAs). There are also trials where PDAs are being used as assessment tools in clinical situations where the assessments can be completed on the spot avoiding the need for students and assessors to complete paperwork and thus saving time. Using Personal Response Systems (PRS) was also seen as an effective method to gather student views in lectures where there may be several hundred students and where

the lecturer would find it hard to gather opinions and stimulate discussion via traditional means. Other examples include podcasting of lectures and revision guides and using text messaging to inform students about timetable changes.

There are numerous other examples (e.g. Traxler & Riordan, 2004, Kukulska-Hulme, 2006, Cochrane & Bateman, 2010) but the common thread is that these are all tools which should augment current forms of learning and thus should not clash with existing strategy i.e. not necessarily disruptive. Another goal of a university's strategy is to widen participation in higher education (Browne and Great Britain. Department for Business, 2010) and it would seem that *m-learning* could be part of a more flexible approach to students, allowing access to institutional IT and learning technologies from a wider variety of devices. However, many universities appear to be still wedded to the model of lecture attendance and provision of fixed IT laboratories and indeed universities have continued to invest heavily in capital building programs since 2007. However recent changes to higher education funding may encourage new ideas on learning spaces. As seen through the examples, *m-learning* has benefits and can fit into university's current strategy but the disruptive potential of the technology may start to create a conflict between a university based on fixed access points in terms of lecture theatres and IT labs to one which embraces more remote and student centred learning which fits in with students' other work and life needs.

4.3 Barriers to Innovation

As this initial field study has indicated there are many potential factors which could detract from *m-learning* embedding with evidence of some of them already visible during these early trials. There is significant commonality between the

issues raised by respondents and the table of possible research questions (Table 1 Chapter 3), reflecting the influence of this initial field study on the literature searches. Issues raised during the interviews by respondents include:

- Lack of skills in mobile technologies (lack of training and support – links to Q6 and Q7 Table 1)
- Ease of use of devices and fear of integration problems (technology complexity- links to Q10 Table1)
- An unwillingness to get involved from IT Services (fear of change and aversion to risk and lack of support – links to Q23, Q24 Q25 Table 1)
- Objections to the technology as an acceptable way of teaching (philosophical and epistemological objections – links to Q25 and Q26 Table 1)
- Lack of any strategic planning or strategy for mobile technology (links to Q23, Q24 Table 1)
- Mobile devices not fitting the model of IT provision in universities nor fitting the traditional models of depreciating and replacing capital equipment (links to Q5 Table 1).
- Lack of a business model to enable students to access information economically. Who pays the cost of downloading information?
- Age demographic of academics (lack of skills and aversion to change – links to Q6 and Q7 Table 1)
- Shifting skills mismatch between academics (less skills in new technologies) and students (increasing skills in new technologies) (Links to Q6 and Q7 Table 1).

- Mismatch between university transmission model of learning and student-centred socially constructed model of learning which is predicted to be favoured in future national education strategies (Great Britain Department for Business Innovation and Skills, 2011) (Links to Q11 and Q12 Table 1).
- The technology use becoming stifled by debate in ethics committees as to what usage of mobile devices will be allowed and in what situations.
- Concerns from academic staff that *m-learning* might extend working hours and disrupt their work-life balance (Links to Q4 and Q11 Table 1).

The most significant issues revealed in this initial field study, which were not so apparent in the literature, were the business model issues and the potential conflict with the institutional IT provision model. These two issues are explored in the subsequent field research and are reflected on in Chapter 9 (See Section 9.1).

4.4 Chapter Summary and Conclusion

Reflecting on this early research, the main benefit has been identifying a series of issues that have enabled the researcher to shape the questions that would form the key guidance for the main field research. The fundamental issue arising from this preliminary field research is the possibility of a mismatch between the potentially disruptive nature of the technology and the existing university organization. How that organization starts to evolve its strategy is a key issue to study in the field research. Does the university organization constrain the use of the technology or does the technology start to initiate changes in that

organization (See Section 10.2 for a comparison of how different institutions respond to *m-learning*)? This question poses a methodological challenge to the field research in that organizations may change very slowly but temporal constraints predicate against detecting such changes. The next chapter examines the methodology framework that will be used to shape that field research.

5. Methodology

The previous Chapter (Chapter 4) described the initial field study which helped to both focus the literature searches, discover potential embedding issues and identify active *m-learning* projects which could be investigated further. This chapter now develops a methodology to achieve the aim of that further investigation, and explore differences in approaches to embedding between institutions. The initial field study was a market research exercise, in effect a Phase 0 of the research. This chapter develops a further two phases of field research: Phase 1 which is a pilot case study (Project SMS) and Phase 2 which is the major case study underpinning the theoretical contribution of this thesis (Project MED), and the results can then be compared between cases and institutions to refine the theoretical contribution (Phase 3). This chapter demonstrates how a methodology was developed to arrive at this four-phase approach.

5.1 Background

Latour's 'follow the actors' (Latour, 2005, p. 227) is perhaps the best guidance to use in looking at a research design, which would gain a deeper understanding of the *m-learning* embedding processes through Actor-Network Theory. Whilst this does not immediately imply interviews and observation as opposed to surveys or questionnaires, the word 'follow' strongly suggests a longitudinal study.
Looking at some of the possible research questions emerging from the literature enables consideration of the types of information that the field research needs to solicit. It is attempting to develop theories that will explain university responses to *m-learning*, This will need to gather evidence of the technology's impact on

the university environment through the various stakeholders, namely the people that use it and the processes that it impacts - lecturers, students, administrators, executives and IT service providers on the one hand and strategies, policies and committees on the other. It is also focusing on the two-way interaction between the organization and the technology as both are expected to 'change in the innovation process' (Rogers, 2003, p. 425). Most of this knowledge is going to be based on people's experience so will be in the form of attitudes, beliefs, opinions, understandings and experiences and not likely to be in the form of readily-available numeric data such as statistics and measurements. There is also the consideration that this is a new technology in its infancy of deployment, so the amount of data available will evolve over time. Therefore there are pragmatic considerations in terms of what data can be accessed in such an immature situation; the initial field study would indicate that most institution policies or strategies would not encompass *m-learning* implying the need to solicit the information from key individuals in the institution. Questioning and observation over a period of time would appear to be the most appropriate strategy of discovering how those local *m-learning* networks interface with the institutional global networks.

5.2 Epistemology

Within this thesis, epistemology is taken as the philosophical grounding to decide what kind of knowledge is possible within the context of this topic (the embedding of *m-learning* in HE), and how to ensure that that knowledge is legitimate (Crotty, 1998). Through reference to literature, the term ontology will also be used in the discussion. Ontology is seen as the nature of existence and the

structure of reality but this sits alongside epistemology and 'ontological and epistemological issues tend to emerge together' (Crotty, 1998, p. 10). The researcher's epistemological instinct is based on an interpretivist paradigm with a view that knowledge is socially constructed. The researcher would see the main evidence to record and analyse being people's practical experience and opinions of using *m-learning* technologies in Higher Education, what they see as the benefits of this technology and the drawbacks and how they see *m-learning* fitting into the institutional context. As a new technology in a new context (universities), there is a limited amount of published literature on the context of institutional embedding, to form a judgement at this stage and then test that judgement. It is thus difficult to propose a hypothesis that could be tested. Such a hypothesis could easily be testing an insignificant argument or issue. There are a wide variety of potential barriers to the 'translation' of *m-learning* into the university organization and it is difficult to propose a hypothesis which can provide the coverage of issues and elicit the depth of understanding. It may also prove difficult to create measures of acceptable external validity or reliability when dealing with a less understood phenomenon like *m-learning* embedding (Edmondson and McManus, 2007).

The research will be best directed by the ideas discovered through the research process with the aim being to gather 'rich data from which ideas are induced' (Easterby-Smith et al., 2002, p. 30). However, this non-positivist viewpoint doesn't necessarily mean that a qualitative approach of some form is a given, even though the 'nature of the phenomena' encourages it (Mason, 2002, p. 11). The initial literature review has, through investigating innovation diffusion,

actor-network theory and *m-learning* literature, revealed a significant number of factors that could play a prominent role in the strategy for deployment of m-learning. All these factors generate research questions, which in turn could be translated into a series of questions that could be measured via a questionnaire or survey. Thus a quantitative approach is not ruled out by the questions or the data they may solicit.

In the initial field study phase of the project, an interview approach was chosen and this was vindicated by uncovering a number of issues that were not anticipated by the literature review, and thus were best solicited through semi-structured open questions. An advantage of the interview approach is that it gave the opportunity to explain the research to an interview subject in a much fuller sense than a written introduction to a questionnaire or survey (Oppenheim, 2000). From a practical point of view it also allowed feedback and validation of the findings of the research to the interviewees who, in turn, have enabled further access for the more in-depth field study. All the evidence to date suggests that for this project a qualitative approach 'is much better suited that a quantitative one to the task of understanding how complex, highly context-sensitive processes unfold in organizations and how they impact on those involved' (King, 2000, p. 590).

The research has clearly stated that it planned to use ANT as a lens on the data. But is the use of Actor-Network Theory consistent with the interpretivist paradigm suggested above? This is a problematic discussion as the authors of ANT have specifically denied that it has an underlying ontology and

epistemology most notably expressed in the comment by ANT's main proponent ' there are four things that do not work with actor-network theory; the word actor, the word network, the word theory and the hyphen' (Latour, 1999, p. 16).

There are three main principles of ANT which touch on ontology and epistemology namely agnosticism, generalised symmetry and free association (Callon, 1986a). Agnosticism means that the researcher has to be impartial towards all actors in the network be they human or non-human (technology, policy or strategy in this *m-learning* case). Symmetry refers to the creation of networks where actors and non-human actors have equally significant roles and the conflicting viewpoints of these different actors can be explained in an abstract and neutral vocabulary that works in the same way for all actors, be they human or technology. Finally the idea of free association means that there can be no assumed distinctions between the technological and the social worlds in coming to an understanding of the phenomenon being researched. These terms which all focus on the equal significance of human and non-human actors are seized upon by critics of ANT, seeing it as a kind of war where innovators and scientists enrol technology into their heterogeneous networks in order to make that technology the dominant force in the organization and thus irreversibly translated or embedded (Amsterdamska, 1990).

Interpretivism has a constructivist ontology in that realities about the world are made sense of by the researcher. As such, an understanding is constructed by the researcher which implies some control over the findings - a selection of the truth. But ANT has a much more open ontology which dictates that the actors speak for

themselves thus creating an opportunity for critics to claim an incompatibility with a constructivist approach. ANT proposes that forces in the interplay amongst actors themselves define, constitute and construct this interplay (Law and Hassard, 1999).The argument is that an interpretivist position is imposing some structure on the data being gathered rather than 'allowing' the actors to construct their own reality. However even when ANT is adopted as an all embracing research approach, if interviewing people is the chosen approach then clearly the questions are going to play a part in constructing the responses received – in other words the actors may be speaking for themselves but only within the researcher's 'script' and thus some constructivism is inevitably at work.

In practice although there is a potential philosophical conflict here between the chosen epistemology of this research and ANT, there are many IS researchers who have adopted interpretivism and ANT. They are taking the position on ANT, like this researcher, that it is a lens on reality rather than a fundamental ontology (Walsham, 1997, Wynn, 2001). The literature reviews have already identified that Law and Callon's global/local model and its points of passage are the main reason for selecting ANT and so, in effect, the research is already focused on a sub-set of the whole Actor-Network theory. This is the main justification for its use as a lens in this instance even if there may be some potential conflict in epistemological terms. This conflict between reality constructed in the researcher's mind from evidence gathered, versus an ontology of ANT which finds reality emerging through the heterogeneous networks of actors that are studied, is highlighted in a paper that argues that interpretivism is

suppressing the true ontology of ANT (Cordella and Shaikh, 2003). However the true ontology of ANT remains difficult to pinpoint, Latour suppressing explicit mention of how evidence is gathered to support analysis of real-world projects through Actor-Network theory. In a study of the failure of rapid transit system development for Paris, we can infer that much of the data was gathered through interviewing key project members but not how that was transformed into an actor-network analysis of the project (Latour, 2002). Hence an interpretivist approach to this analysis of *m-learning* projects may be challenged by this debate on the ontology of ANT but is wholly consistent with methodologies adopted by highly-respected IS researchers such as Geoff Walsham (Walsham, 1997). The methodology has however, been influenced by Actor-Network Theory in that looking for points of passage between *m-learning* projects (the 'local') and the university organization (the 'global') has predicated the need to add appropriate questions to any interview scripts that might illuminate those points of passage. Thus although the research design might be interpretivist led, it has certainly been adjusted by ANT in some aspects.

In choosing interpretivism as the over-arching methodology then consideration needs to be given to its use in IS Research. Walsham (Walsham, 1995) building heavily on the work of Latour on looking at science and engineering projects (Latour, 1987) , reviews the emergence of interpretivism in IS research. Walsham highlights the work of Checkland's Soft Systems Methodology (SSM) (Checkland and Holwell, 1998) as looking at the intervention of organizations on the management of IS as being based on an interpretive stance and similarly the interpretive nature of research by Kling (Kling, 1987). There is also considerable

number of studies looking at the social implications of IS influenced by the work of Zuboff (Zuboff, 1988) and Orlikowski (Orlikowski and Baroudi, 1990). Numbers of interpretivist studies have continued to develop and even the most ardently positivist journals have published a number of IS interpretive studies (Walsham, 2006). Hence both the use of interpretive methods and Actor-Network Theory are supported by approaches demonstrated in existing IS literature and thus this choice is a valid way forward for this study of *m-learning* projects.

5.3 Defining embedding and simplifying the research

Through the thesis introduction and throughout the literature review, the term embedding is frequently referred to. The context of this research was that either wholesale adoption by students or *m-learning* becoming a core technology offered by HE institutions, were likely outcomes that would be observable through the field research. Embedding was considered as the existence and effectiveness of links between the *m-learning* project and the institutional ICT strategy i.e. starting to take outputs from *m-learning* projects and connecting them into IT strategic thinking. The researcher's tacit knowledge indicated this could be one way to distinguish between institutions and identify those with better processes to assimilate the results of pilot projects. Embedding was therefore taken in this context to be evidence that assimilation into future IT strategy was beginning to appear rather than evidence that *m-learning* was a widely-used core technology.

This refinement of the term embedding also allowed another simplification to how this could be modelled in ANT terms. Essentially in looking for links between the local *m-learning* project and the global institutional IT strategy, two albeit heterogeneous and potentially complex, actor networks are defined. The effectiveness of the points of passage between these two networks was a key area to examine and this focused the field research to look for evidence of this, discovering what was happening at the interface between these two networks. This influenced the field research both in choosing who it would be appropriate to interview and developing questions which would give insights into the relationship between these two actor networks.

5.4 Case Studies

The definition of embedding and the links between local networks (*m-learning* projects) and global networks (university policy and strategy) as the research focus suggests an in-depth study of one or more *m-learning* projects would be appropriate. Such a case study approach is a common method in interpretive IS research (Walsham, 2006) and indeed has been used successfully in studies involving both ANT and IS (Walsham and Sahay, 1999). If advocating a case study approach then consideration must be given to the number of cases, the types of organization to approach and the length of time such a study will encompass. The research question should dictate the type of organization to approach (i.e. universities) and the type of data to be gathered (Eisenhardt, 1989) and furthermore it may help define the number of organizations and perhaps indicate timescales. The research question proposed for this study is:

> "How do university organizations (business models, modes of operation, people, processes) adapt to a potentially disruptive innovation like *m-learning* and what factors and working practices support or hinder that adaptation?"

This research questions talks about organizations and therefore could suggest looking at multiple organizations and hence comparing and contrasting of observations. It also talks about adaptation, which is not a discrete process and thus implies a longitudinal study.

The literature review on innovation diffusion has revealed many factors, which can play a part in influencing how *m-learning* might diffuse in a university. The researcher's epistemological and ontological preference would point towards capturing information through dialogue with people, be that in the form of active questioning in the form of interviews or group discussions to more passive forms involving observations of people through meetings or perhaps analysis of written information in project documents. The research question suggests that information is gathered from more than one university in order to be able to draw conclusions that can be linked back to ANTs local/global model and support a contribution to knowledge that is widely applicable. The research is seeking evidence as to why projects continued beyond funded trials or are terminated and what decisions and agreements (or translations) were made which contributed to that success or failure. This hints at using case studies as a methodology but case study is often thought ' a less desirable form of inquiry' (Yin, 2009, p. 10) used in a loose fashion. So, what is a case study? According to Yin, the essence of a

case study is that it 'tries to illuminate a decision or set of decisions, why they were taken, how they were implemented and with what result' (Yin, 2009, p. 12). The key focus of this research is ultimately the existence of a strategy or mechanism which demonstrates whether a university has the potential to extend its use of *m-learning* beyond funded research trials or pilot projects. Hence case study methodology appears to be a good fit for this project.

5.5 Case Study Sample

Given the case study decision, what should be the sample size? It could be argued that a single site case study is more practical and could potentially give interesting results. Whilst this appeals from a pragmatic standpoint, the data gathered so far advises against this. Looking at the ten institutions that were interviewed (See Chapter 4) and evidence of projects in other universities, there are broadly three categories of project at work:

1. Projects that are funded through external research grants. The issues here are how the project evolves from being funded externally to being funded and approved by the university. In ANT terms, how do the respective project and university networks form points of passage and translate themselves through this process?
2. Projects that are funded by the university and have some level of support albeit more on a faculty basis. Will this type of project embed itself after the initial burst of enthusiasm and how does it form points of passage

which can inform institutional strategies and thus become an embedded service?

3. Projects that are introduced almost covertly by individuals who decide to pull in some of these new technologies to benefit their students using their own effort and even money to get projects up and running. How will the actor networks here transform themselves from covert operation to something which finds points of passage to the wider university community? Will their initial covert nature engender an insurmountable resistance from the university management and administration?

The innovation literature (Section 3.2) suggested this might be a significant categorization in that difficulties in embedding might be least expected for projects that the university is already financially supporting and might be greatest in so–called 'maverick' projects which appear to have no management approval (Flowers, 2008). In other words, the origin of a project might be a significant factor. However, perhaps serendipitously, having identified a case of the third type, namely a maverick innovator, and gained access, it quickly became clear that access would not be consistent enough for a proper analysis. Furthermore, the project in question, using podcasting to deliver summaries of lectures, quickly caught the imagination of other tutors in the institution and within a short time became a widespread service that was supported by the institution. In other words the project entered category two above and was no longer a maverick project. This case study was abandoned and in hindsight this whole subject of the maverick innovator and *m-learning* is probably worthy of a dedicated thesis and

thus this case was discarded from the sample and the research proceeded with two distinct cases.

From case study methodology each *m-learning* project can be treated as a unit of analysis (Yin, 2009) and thus the aim was to have two units of analysis comprising each of the two types of project outlined above. In Yin's terms this could be considered as a form of theoretical sampling, each unit of analysis being chosen to contrast differences in origin of *m-learning* projects and chosen to expect potentially different outcomes. If each of the *m-learning* projects constituted a single university then it would appear to have a classic multiple case design. However, one of these cases is actually a project that is being trialled across five separate universities working in a collaborative partnership. Although this can be viewed as a single project there are likely to be differences between these five universities in how this technology is embedded. The original logic has been to choose cases based on the project origin – funded, unfunded and maverick - but it is possible that the more striking difference may be the university organization themselves and what structure they have in place to develop these projects beyond some initial limited trial. Hence the research may flip from contrasting two projects to contrasting six universities. How does this compare with the principles of good case study methodology?

Yin (Yin, 2009) defines four types of case study design that essentially have the two variants of single or multiple cases with the added variation of embedded units of analysis where an individual case involves more than one unit of analysis. For example, an organization might be a single case but individual

departments might be embedded units of analysis. Applying this logic to the proposed design would appear to work satisfactorily in one of the projects as it neatly maps to a single unit of analysis i.e. project equals university. However the other case would appear to have five embedded units of analysis in that the project spans five universities. So, does this question the validity in that it doesn't completely match Yin's designs? In other words this is a multiple-case design consisting of two cases, one of which has distinct embedded units of analysis.

The theoretical sampling method used to select the two cases, each one selected to contrast the types of project, is a form of 'contrary replication' (Eisenhardt and Graebner, 2007). The fact that one of these cases consists of five organizations potentially enriches the design. It is also worth stating that the choice of cases available to a researcher (especially a PhD researcher) is usually limited so it might be wrong to discard this five university case on the basis of not neatly fitting into the mapping of project equals university (Eisenhardt, 1989). Also this specific case was probably the largest *m-learning* project in UK Higher Education at that time, so represents a particularly strong example of the category of externally funded project. Furthermore, the fact that the study will have data from six universities strengthens the potential findings, rather than weakens them. Multiple cases can create more robust theories 'because the propositions are more deeply grounded in varied empirical evidence' (Eisenhardt and Graebner, 2007, p. 27).

M-Learning is an immature technology in its infancy being introduced in at least three different ways. Focusing on one institution is likely to run the risk of identifying one set of issues (e.g. same central IT policy, procurement policy, QA and Ethics etc.) and thus make it riskier to extrapolate results to form conclusions that are more widely applicable. The sample of case studies of two projects covering six institutions could be criticized as being unrepresentative of the wider university experience. Sampling is associated with the logic of probability and statistics that will attempt to show that the sample is representative of a wider context. But in qualitative methods, 'the logic of probability is rarely employed' (Mason, 2002, p. 83) and this projects approach is based on 'theoretical sampling' (Corbin and Strauss, 1998) where the sampling is 'directed by the evolving theory' (Corbin and Strauss, 1998, p. 203).

A final consideration in choosing case studies is whether the theory being developed is best evaluated after completing the field research or whether some form of pilot study should be undertaken first. The simpler one institution case was undertaken initially with the aim that this would allow a theoretical analysis, using ANT, of a smaller data set. Thus if the data collection methods needed to be refined or the theoretical analysis of the data reveals the need to ask different questions or seek other types of data, the pilot case study affords that opportunity. Yin acknowledges that a pilot case study can test out methodology and 'can provide information about relevant field questions and about the logistics of the field enquiry' (Yin, 2009, p. 94). Indeed the pilot case study can be more important and hence more effort can be devoted to this phase of the

research and ‘under no circumstances should the pilot case be…overly informal’ (Yin, 2009, p. 93).

The two case studies chosen are:

- Project SMS. This is a text messaging project in one of the largest universities in the UK. Text messages are being used to alert students to urgent changes to timetables, cancellation of any lectures due to tutor illness and various administrative events such as assignment hand-in deadlines or requests to return loan equipment. The service is for the most part financed by the university itself. Project SMS will form the pilot case study.
- Project MED. This is a research grant funded project which involves five institutions working in a partnership. The overall programme is wide-ranging and concerns assessment of health students whilst on clinical practice during their undergraduate course. The specific part of the project for *m-learning* is development and deployment of an *m-learning* application which will be used to record assessment results on a smartphone. The trial involves over a thousand students across sixteen different health professions and spread across the five university partners.

Further detail on each of these cases follows later in the thesis when the findings from each case are discussed.

5.6 Case Study Protocol

Before commencing the field research, there is the need to identify what questions need answering and what data collection methods are available to

solicit the answers. As a researcher who is trying to build theory from data, then combining multiple data collection methods should be considered (Eisenhardt, 1989). A case study protocol is intended to guide the researcher in carrying out the data collection from a single case study (even if it is one of several units of analysis in a multiple-case study) and increase the reliability of the research (Yin, 2009).

Yin defines four parts to the contents of a case study protocol: overview, field procedures, case study questions and expected contents of the case study report (Yin, 2009). The following table (Table 3) represents a case study protocol for this project:

Overview of case study project

The theoretical background to the project is extensively covered elsewhere in this report but a summary is:

- Identify a project which is introducing *m-learning* technology into a specific institution
- Discover how the project was initiated and who the main participants are.
- Identify areas where the project has interacted with the overall university organization (such as faculty managers, business managers, IT services, procurement and accounting) to examine the points of passage.
- Collect data on how these interactions progressed, what issues were raised and what outcomes were from resolving these issues. The data should include evidence from both project participants and those the project interacted with.
- Collect data on how the *m-learning* will be embedded into the university. - Considering the issues raised on the barriers to embedding, perform further investigation as to how these will issues be resolved and gather evidence on what practices succeed or fail and the reasons behind such success or failure.

Field Procedures

- Brief the *m-learning* project staff on the purpose of the case study and what information is being sought
- Explain that access is needed to non-project staff such as faculty management, IT services, accounting, procurement etc. and establish whether such access is realistic and identify key players. Establish who will sponsor introductions to key players.
- Ensure that any permissions from local research committees and ethics committees are dealt with in advance.
- Reassure project staff on ethical approach. Some of this technology is being used in sensitive areas such as clinical situations so explain that access to individual students is not needed nor will it be necessary to observe students using the technology. Be prepared to explain this to local ethics committees if required.
- Explain the type of data that will be gathered and that interviews will be recorded digitally.
- Establish possibility of examining project documents such as policies and procedures.
- Are there project meetings that could be observed (could vary between cases depending on nature of project)?
- Are there relevant weblogs or wikis that can be examined?
- Make the offer of disseminating project results locally to project team or contributing to their local research program.
- Record data for interviews using digital recorder. Backup onto PC and secure cloudspace.

- Transcribe the data using a transcription service.
- Offer to feedback interview and case summaries to the project team. This can provide valuable validation of results.
- Be flexible on interview schedule – prepare to multi-task between cases so always have several options if some interviewees are not available at planned dates.
- Be prepared to re-interview some subjects as it may be necessary to look again at issues of embedding towards the end of a project or academic year.

Case Study Questions

Type of Question	**Level of Question**	**Sources of data**	**Notes**
What are the principal factors which support or hinder the *m-learning* embedding?	2	• Interviews with *m-learning* project team members. • Minutes of project team meetings • Correspondence raising issues with university support services • Project MED blogs and wikis	See. Note 1 below
How are issues of interaction with university support services progressed? What practices succeed or fail?	2	• Interviews with *m-learning* project members • Interviews with support services, Minutes of meetings to resolve issues • Agreements made with support services • University policies	
What is the plan to embed the innovation?	2	• Interview with *m-learnin*g project members • Interview with support services	

		• Access to student and staff surveys • Interviews with faculty managers	
Are there differences between institutions in both the barriers to diffusion and the proposed route to embedding? Looking for evidence which distinguishes universities such as variations in decisions making process, levels of autonomy, organization structure etc. Are there differences between the embedding of projects based on their origin? i.e. externally funded, or internally initiated	3 3 3	These are multi-case questions and as such will have to be extracted from the data recorded from the individual cases (from both interviews, meetings and examination of documents). It is possible that further field work may be required to explore differences between cases. This may necessitate: • Interviewing some project participants for a second time. • Observing some further meetings • Examining further documentation.	See Note 2 below

Case Study Report

The case studies are part of this PhD thesis so, as such, will not be published in stand-alone mode. However some basic principles will be followed in describing each case and the data analysis

Contents of the case study report(s) will contain at least the following:

- Outline of data collection procedures used
- Timeline of case study

- Any Issues/problems in data collection
- Analysis of issues raised as barriers to embedding
- Analysis of path to organizational embedding.
- Reflection on findings using Law and Callon's local/global model

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Table 3 – Case Study Protocol

Notes on Case study protocol

1. Yin defines up to five question levels for the case study protocol (Yin, 2009, p. 87). Specifically most of the questions above are placed at level 2 as they are very much about the case rather than the individual being interviewed or the document being examined, following Yin's guidance to 'concentrate heavily on Level 2 for the case study protocol' (Yin, 2009, p.87). These questions will map into specific interview questions which will be asked of an individual but the true purpose is to gain insights on the case rather than on the individuals involved.
2. The level 3 questions compare cases and cannot be asked until the individual cases have been analysed. It may be necessary to go back and collect more data to fully explore these differences.
3. Interviews will be carried out using semi-structured questions and will be recorded and transcribed for later analysis and coding. An estimate would be 5-10 interviews per institution.

The Case Study Protocol is focussed on levels 2 and 3. The following table (Table 4) indicates why other levels are excluded from the Case Study Protocol:

Level	Description (Yin, 2009)	Reason for Exclusion
1	Specific interviewee questions	Study is about institutions and not about individuals
2	Individual Case Questions	Included
3	Multiple-Case Questions	Included
4	Questions about an entire study	This is going beyond the individual case study evidence (comparing with other literature or published data). In effect this is the discussion and contribution in Chapters 9 and 10 where comparison of results with literature is discussed.
5	Normative questions about policy recommendations	Outside the scope of this study – comparing cases and institutions is the focus of this study to examine differences in embedding strategies.

Table 4 – Case Study question levels

Yin notes that questions at level 4 and 5 go well beyond any individual case study protocol and the focus of the case study protocol should be the data collection from a single case (Yin, 2009).

5.7 Building Actor-Network Theory from the cases

Assuming that the case studies are able to gather enough evidence to interpret the actor networks, this leaves the challenge of analysing the interview and observation data, extracting common themes and linking this back to theory. The qualitative case study approach outlined, through a process of data collection via interviews and secondary sources, does not start with a pre-conceived hypothesis although it does suggest using ANT as a framework for theoretical analysis. As

the literature review illustrates, *m-learning* is a new topic area with no agreed frameworks for looking at how it will be embedded, emerging in the existing literature. Rather, in this project, theory will emerge from the data collection and analysis. Theory derived from data is known as 'grounded theory' and a number of methods are available to enable researchers to analyse and interpret the data (Strauss and Corbin, 1998, p. 12). Some of these methods will be used to guide the interview process, observation and data analysis with the developing theory being re-examined and revised as new data emerges from the interviews and any secondary sources. Yin acknowledges that grounded theory is relevant to case study techniques calling a parallel technique 'explanation building' (Yin, 2009, p. 141) as an iterative process for explaining a phenomenon. In a sense this use of grounded theory is a two-stage process. The data from project SMS (text messaging) will be used to construct a theory that will then be tested further by carrying out the field research and analysis on Project MED. But even in looking at project SMS, some method will need to be used to code the data so that key issues can be highlighted and then explained using the ANT local/global model. The originators of grounded theory, Glaser & Strauss (Glaser and Strauss, 1967), developed a number of coding techniques to be able to look at interview transcriptions or documents and tag common themes or issues. In fact, this is an iterative process in that the researcher is likely to invent many tags on the first pass through the data and then have to re-code and combine certain themes to produce a manageable set. There is a clear contrast here with quantitative research where we require data to fit into pre-conceived templates or codes, 'the researchers interpretations of data shape his or her emergent codes in grounded theory' (Charmaz, 2000, p. 515).

The decision to use grounded theory is not based on any epistemological argument but purely by a pragmatic one; the coding techniques and methods described by Glaser and Strauss 'produce descriptions of organizational reality which are easily recognized by the members of the target organization' (Lansisalmi et al., 2004, p. 243). Another important aspect of this work will be validation of the emerging theory with the case study participants, showing them the actor-networks that have been created and seeing whether they agree that it helps explain the trajectory of *m-learning* projects within their institution. Results will also be presented at any conferences or interest group meetings and indeed interim results have been presented at project conferences (for project MED), international conferences (such as mLearn) and national interest groups such as those run by JISC. Apart from the above pragmatic reasons, there are also numerous grounded theory based studies on organizational and radical innovation that supports the viability and applicability of this method to this IS context (Carrero et al., 2000, Lowe, 1995, Von Krogh et al., 2003).

Grounded theory involves the concept that interviewing and data gathering should stop when the theory stabilises and new data does not add to the theory and hence 'saturation' occurs. Throughout the process, the researcher needs to maintain a balance between objectivity in recording information as it was discovered, whilst being sensitive to the emergent theory (Strauss and Corbin, 1998, p. 42). It is worth re-iterating that grounded theory techniques are not being used in their purest phenomenological sense where there are no pre-conceived theories that could influence the findings. Given the wealth of

research there has been into innovation, then it would be unrealistic to enter the field research without some expectations of what factors and issues could be identified. It should also be noted that the researcher had already chosen a meta-theory in the form of ANT and local/global model which clearly influence the emerging theory. Also the researcher cannot ignore his own skills and experience having spent many years working with the mobile phone industry and having recently researched the use of mobile data in business – 'insights do not occur haphazardly…they happen to prepared minds during interplay with the data' (Strauss and Corbin, 1998, p. 47). Rather than a pure phenomenological approach, grounded theory is chosen as an effective method of developing a changing theory and ensuring that this theory is soundly linked to the research data. There is also some synergy between theory which emerges from data and Latour's 'let the actors speak for themselves' (Latour, 2005) something which has been recognized in more recent grounded theory literature (Urquhart, 2010).

5.8 Interview & Observation techniques

Access to the suitable data from each of the chosen cases was a combination of interviewing key staff within the projects, attending meetings where possible and access to documentation that could be relevant. Interviews were by far the key source of data and the one for which considerable preparation would be needed. An advantage of the interview approach is that it gave the researcher an opportunity to explain the research to an interview subject in a much fuller sense than a written introduction to a questionnaire or survey (Oppenheim, 2000). It was also expected there may be ideas that will emerge from the interview process which could not be anticipated through pre-planned questions. It is by no means

certain that the literature review will have captured all the issues that might influence diffusion of m-learning and this interview approach increases the chances of identifying issues that are not present in the literature. A semi-structured interview script was created, one that would ensure consistent questioning across interview subjects but would allow flexibility to explore ideas that emerge through the interview. The interview scripts were slightly different for each of Project SMS and Project MED- asking the same basic questions but being sensitive to the different contexts of the projects. Balance needed to be struck between being a passive researcher to being one who gives too much direction to the respondent (Walsham, 1995). Generally each interview would start with an explanation of the research and how the interview data would be used and this usually had the effect of putting the respondent at ease and helping the interview conversation flow. The interviews were recorded on a digital recorder and transcribed by a third-party service, thus allowing the researcher more time to devote to analysis. There are issues in recording interviews as this can make respondents more nervous or less willing to share experiences and of course this may not necessarily capture some of the tacit, non-verbal aspects of the interview (Walsham, 2006). The experience from this research was that participants were very willing to cooperate and there were no apparent issues of withholding information.

In addition to the interviews, which form the main body of evidence, there were opportunities to attend meetings relating to both projects (cases) and this also provided evidence that could be combined with the interview data. Although a secondary source, observation provided a valuable tool, ‘whether or not you

locate yourself as a researcher within the ethnographic tradition' (Mason, 2002, p. 61). In these meetings the researcher made notes on any significant issues that related to this research and also had access to minutes of the meetings. The style of observation chosen was not the traditional ethnographic approach of completely passive observation but more to develop a "membership role" within the community under study (Denzin and Lincoln, 2003) . As many members of the groups being observed were also interview subjects, a more active role helped create an additional information flow which could be recorded. Data from observations was combined with interview data using the same coding techniques to tag information so it can be attached to the same theoretical framework. In addition to the observation, the least significant aspect was looking at documentation from the projects which again was performed by looking for any evidence which could be combined with codes being developed through the interview analysis.

During the research, there was a strong interplay between theory and practice with theory being re-examined and revised as new data emerged from the interviews and any secondary sources. Before the interviews began, some conceptual ordering of results from the initial field research and the output of the literature review was performed. This allowed the interviews to be structured by focusing on issues that were already apparent for *m-learning* projects and also looking for questions that might illuminate the presence or absence of 'points of passage' in ANT terms. This helped organize the questions and develop a framework in which the interview data could be captured and analysed. This framework evolved as the research progressed and was continually tested by

making ‘theoretical comparisons’ against the data gathered (Strauss and Corbin, 1998, p. 80). These comparisons highlighted more categories and properties that in turn could be used to examine the data in different ways. In this way the framework evolved to unify the theoretical framework with the experiences of the universities investigated. A number of different coding procedures were used to categorise the data to refine and link categories and subcategories (Strauss and Corbin, 1998, p. 55). Essentially, this represented in grounded theory terms, the stages of open and selective coding. Open coding is the tagging of concepts that appear within the data such as the concept of ‘limitations of a mobile device’, recording all instances of interview comments or observations which demonstrate evidence of that concept. Essentially, the researcher is looking for patterns in the data that are repeated sufficiently to identify themes on which a theory might be built. This was followed by a stage of selective coding which represented the process of refining these themes into a theory, picking out what were the key concepts to explain what the data was saying. For example, points of passage into the institutional IT strategy is the ‘central category’ (Strauss and Corbin, 1998, p.146) which coupled with evidence of the timeline of the project within each institution, allowed actor network trajectories to be plotted for each institution. The effectiveness of points of passage emerged as a key difference between institutions which was expressed in a number of ways through the open coding stage, such as evidence that IT responsibility was fragmented or evidence that the central institution IT strategy regarded the *m-learning* project as peripheral. This simplification of the data through selective coding allowed the actor networks to be built for each institution (See Section 6.2 for further

discussion on coding and Section 9.2 for reflection on the use of grounded theory).

Within this case study environment the concept of saturation was treated as a two stranded approach. Once a theory was sufficiently developed and supported by both the data and the emerging theoretical model then no further cases would be attempted. Within an individual institution, saturation would be treated as the point where it was unlikely that further interviews or observations would enhance the theoretical framework that represented that institution.

However using grounded theory also represents a risk in that different frameworks and lines of questioning may evolve as the interviews and data gathering give rise to new ideas and concepts. Thus the questions asked in later interviews may differ from the questions asked in earlier ones. This gives rise to an issue of consistency in how to relate the data from early interviews to the frameworks which emerge in later ones; how to build 'content comparability' into the data gathering process (Schatzman and Strauss, 1973, p. 75). This can be handled by re-examining earlier data in the light of later frameworks with options for 'grounding' the old data in the new theory, discarding some of the data or even repeating all or parts of the interviews to test out the new theories. This is a planned and acceptable risk of any qualitative research and although 'researchers are to some extent tied to their frameworks, they shouldn't be 'tied up by them'' (Easterby-Smith et al., 2002, p. 88).

5.9 Ethical Considerations

Ethically this project doesn't present major difficulties as it is dealing with a largely academic audience rather than individuals and organizations who are seeking to protect their commercial position where the research could carry the risk of disclosing commercially sensitive information. However in interviewing people, access to information that puts the interview subject in a difficult position may occur. For example, if a respondent questions the university's *m-learning* strategy, his or her opinion may be unwelcome by other colleagues. Qualitative methods put the researcher in direct contact with the research subjects and in contrast to quantitative methods 'put the researcher in a considerably more powerful position in relation to individuals' (Easterby-Smith et al., 2002, p. 76). On one or two occasions respondents became uncomfortable with the interviewer following lines of inquiry as they felt it was taking them into areas where they would be too critical of their institutions. In these rare cases, the strategy was to respect the person being interviewed and move onto other questions, rather than push them into areas they were clearly uncomfortable with.

Consent is also a potential issue. Not only do you need to gain the consent of those who you interview but it is also important to ensure that any sponsoring leader within the university being researched is aware of who is being interviewed (Mason, 2002). Everyone interviewed had the option of remaining anonymous in the thesis (and all respondents accepted this option) and similarly names of universities were also removed. The wishes of the individuals and their universities will be respected at all times and interview scripts will not be

published, and will only be seen by the researcher and possibly his supervisory team. Security of transcribed interview scripts will be maintained by holding them securely in password protected cloud storage for a period of up to six years, six years being a guideline that was given by NHS ethical guidelines (NHS, 2012) used in Project MED. The use of suitably secure cloud storage avoids holding any data on institution laptops or desktop computers and mitigates against proliferation of multiple copies of the data (Aldridge et al., 2010).

It is interesting to contrast the two approaches of project SMS and Project MED in gaining ethical approval. For project SMS, ethical approval was filling out a form which declared what the research would be and stating that it would not be seeking information which would be regarded as sensitive (although in hindsight the information obtained could be seen as reflecting negatively on the university strategy). For Project MED, as this involved a health related topic, the researcher had to follow guidelines laid down by the NHS in order to gain access, even though the research was not seeking information regarding medical issues or personal information (NHS, 2012). This required submission of interview scripts, consent forms, information sheet that described the project and a case study protocol to an ethics committee before permission was granted. Although a time consuming process, with hindsight this led to the researcher being far better prepared for the field research then perhaps would have been the case. Once this ethical approval was completed at one of the five institutions in Project MED, reciprocal approval was granted at the other four without the need to submit further information.

5.10 Risks and Issues

A significant risk comes from the argument as to whether the cases and institutions chosen are representative and make it possible to draw conclusions which can be defended as a contribution to theory and practice. In using a grounded theory technique, the size of the sample is determined more by the factors that emerge from the interviews rather than any theoretical match of the sample with the total population. There are no hard rules for determining sample size in grounded theory and Glaser and Strauss talk about reaching "saturation" where no new data is generated by further interviews (Glaser and Strauss, 1967). That guidance is perhaps more applicable to the issue of when to stop data gathering in a particular case or institution and perhaps case study thinking is more appropriate to determining how many cases are a representative sample.

Yin (2009) raises the main issue is whether a particular case answers the questions posed by the research as justifying the sample. But Yin also suggests that multiple-case designs improve the chances of a "good" study; single case designs being more vulnerable if only because 'you will have put all your eggs in one basket' (Yin, 2009, p. 61). However Yin also defends single-case designs especially if a case could be viewed as 'revelatory' (Yin, 2009, p. 49) in that it represents a unique opportunity to study something for the first time. Project MED, as the largest university based *m-learning* project attempted in the UK at this time, could be regarded as a revelatory case perhaps and has clear strengths in that it covers five independent institutions embedded within it. Stake (2000), on the other hand promotes the strength of single cases and argues that trying to compare multiple cases is competing with learning from a particular case (Stake,

2000). Project MED would be a sufficiently unique and revelatory case as to be a justifiable single case study but project SMS gives an extra credibility to the thesis in that it allows the potential to show similar issues in a different situation and thus supports both a comparison of case and a stronger argument for applicability of the results and contribution. A further boost to the validity and reliability is what Yin describes as maintaining a 'chain of evidence' (Yin, 2009, p. 122) showing a link from literature to initial research questions to the case study protocol and finally to the conclusions. The thesis has been constructed to show how the project has evolved over time and should allow the reader to trace the chain of evidence from initial thoughts to reflective conclusion. This chain of evidence approach should also help the reader to determine if the contributions to theory and practice developed in the thesis conclusion are applicable beyond the context of the thesis fieldwork.

5.11 Chapter Summary

The proposed methodology has a number of features. It uses an interpretive and constructivist approach to perform case studies on two projects involving six unique institutions. Evidence is gathered using techniques of semi-structured interview, observation and document examination. Grounded theory techniques are used to code up the data to tag specific themes and chains of evidence. Project SMS is undertaken as a pilot case study both to road-test the methodology and develop techniques of producing an explanation of the project trajectory through actor-networks, piloting the contribution to theory. With confidence built in the underlying methodology and approach to theory building, the project MED case study is undertaken and analysed. The resultant actor networks are discussed with interview respondents to see whether they accurately reflect the approach to embedding of *m-learning* in their institution, a validation of the emerging theory. Finally, conclusions are drawn from both within each project and by comparisons between the two cases to reach a final contribution to theory and practice. This approach is best summarised by the following flow diagram:

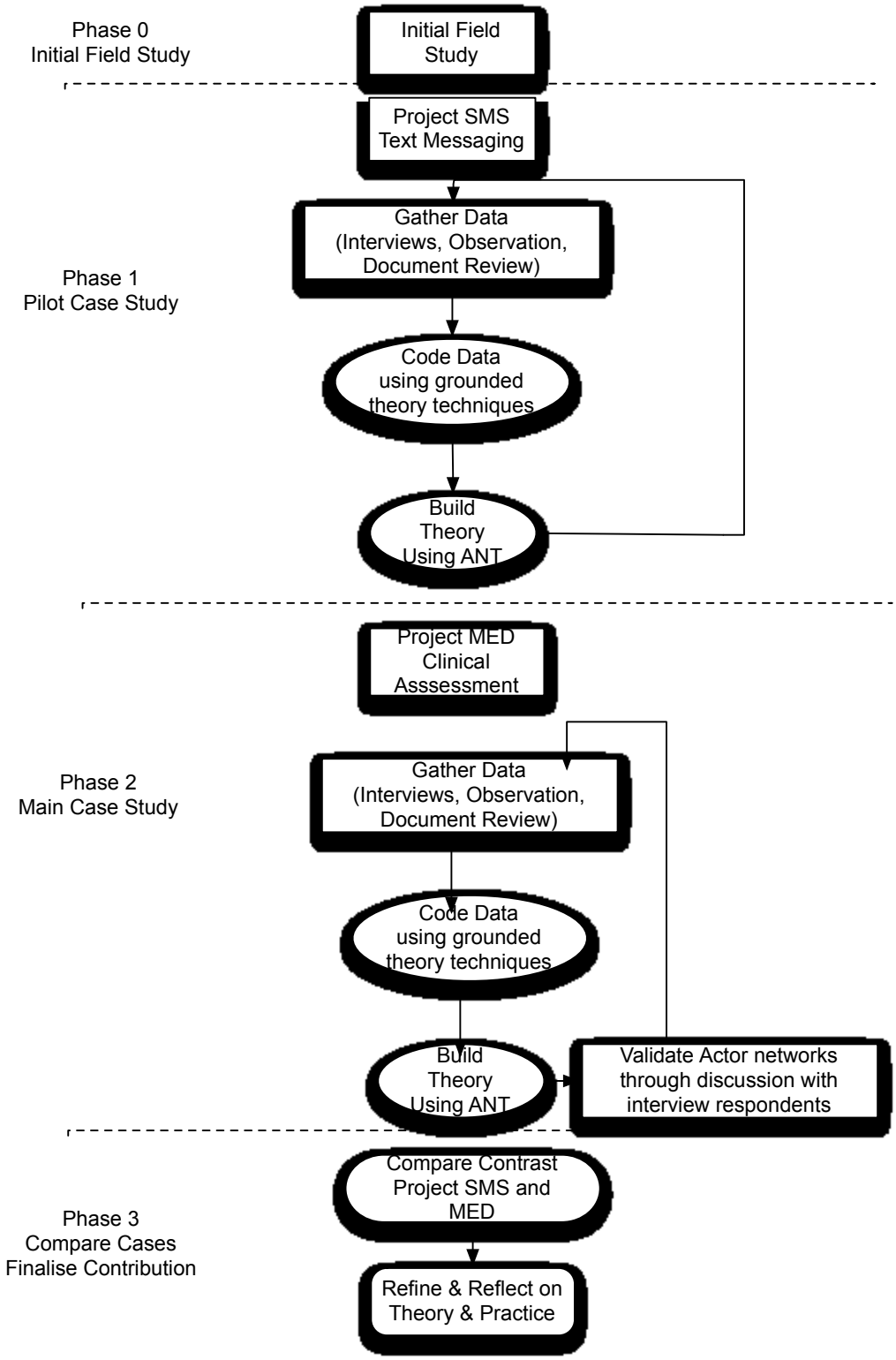

Figure 4 – Flow of methodology

The above diagram (Figure 4) highlights the four phases of the research. The initial field study (Phase 0) is the market research exercise involving ten institutions which was conducted in parallel with the literature reviews (See Chapter 4). A pilot case study (Phase 1 -Project SMS) used to road-test the methodology and benchmark the theoretical lens of ANT on an *m-learning* project. This is followed by a substantive case study (Phase 2 –Project MED) involving *m-learning* in five institutions. Finally, a comparative phase (Phase 3) where conclusions are drawn using results from both case studies to refine the contribution to theory and practice that emerges from the field data. Within the phases, a methodology is utilised which uses semi-structured interviewing involving six separate institutions and by using these multiple units of analysis will provide a stronger base for theory building (Eisenhardt and Graebner, 2007). Using grounded theory 'that is sensitive to issues of interpretation and process and does not bind one too closely to long-standing assumptions' (Suddaby, 2006, p. 641), the transcribed interview scripts plus documentary and observation evidence is coded up to generate and structure the key concepts in order to support the further analysis of the data using Actor-Network Theory.

This chapter has set out the choices of methodology to be used for the field research and the justifications that underlie those choices. The next chapter will put those choices into practice, demonstrating the validity of the field craft on a single institution project involving text-messaging technology. This 'pilot case study' (Yin, 2009, p. 92) will not only test the research methodology but the choice of ANT as a theoretical lens for interpreting the data.

6. Project SMS – Text Messaging

In reviewing the literature and identifying ANT as a possible lens on the data, the challenge was to develop an approach to analysing the data through ANT and representing the findings. The originators of ANT have not been prescriptive in this regard, normally using textual descriptions as opposed to pictures or diagrams. Law and Callon did use a form of transformation axis in their "life and death of an aircraft' paper (Law and Callon, 1992) and Latour occasionally included a diagrammatic representation such as in his study of the impact on France of Louis Pasteur (Latour, 1993a) but most studies discuss ANT in textual terms. However, this is not a methodology issue, Latour having been very clear that he does not attach ANT to any particular ontology or epistemology (Latour 1995). More exactly the research challenge is how to show a path of analysis from textual interview data and documentary evidence to a discussion that talks about actor networks and notions of translation.

Clearly the two case studies identified were of different orders of magnitude. Project SMS studied projects within a single institution and interviews would be the order of ten at most, whereas project MED involved five institutions and hence a much higher volume of data. It seemed opportune to conduct one case study and try to analyse the data from that to produce an ANT representation. This would both try out the methodology but also show whether ANT had the potential to illuminate the data in a way that would result in possible new contributions to knowledge and theory.

In a sense this was the next stage of refinement of the research. The initial field study (Chapter 4) which looked at *m-learning* projects in ten institutions, identified issues and barriers that pointed to a conflict between the needs of *m-learning* projects and the institution's mode of operation, especially in the areas of IT and Learning and Teaching strategies. This initial data also hinted at the possibility of viewing these projects as actor-networks and the issues and barriers appeared to represent gaps between the project actor-networks and the wider institution which could also be viewed as a higher-level actor network, A logical next step is to therefore do an in-depth research on one institution to see whether this notion of actor-networks will illuminate our understanding of those issues and barriers.

6.1 Background to Project SMS

In this large university based in a major city in the North of England, various individuals ranging from tutors to learning and teaching fellows, recognised the potential of using SMS (Short Message Service) as a means of communicating information to students. The university was keen to improve student experience and has targeted frustration arising when lectures are cancelled or their location changed, as an area for improvement. Mobile phone penetration was almost ubiquitous within the university student population, so there was a high expectation that the opportunity to receive important information by text would be popular with students.

In 2006, the university acquired some software (known here as "MCAT"), which allowed messages to be sent to list of student mobile phone numbers. This was

by no means a strategy to diffuse text messaging throughout the institution but rather a service which faculties and central departments could use. The existence of the service was announced centrally via the staff email system and training was offered. There are perhaps two observations here which reflect on the strategic view of the service. One was the charging mechanism, which was very flexible: the university only paid for the messages that were sent and this charge was passed directly to the department/faculty responsible for sending the messages. In other words, faculties and departments could use the service but they were responsible for the costs. This is a sensible approach to piloting a service but reflects the expectation that it would be used sporadically. If making a decision to embed the service a different sort of charging service would probably need to be considered i.e. a service contract versus pay-as-you-go. The other interesting issue is that this text messaging service was very much part of the telephony department and not the IT department. This can be contrasted with other forms of electronic communication such as email, which was under the control of the IT strategy. This division of IT responsibilities is something that this thesis will return to.

It is also interesting to note that other ad-hoc text messaging services were used across the university in various local projects. One example is in art and design where postings on a shared portfolio website were notified to interested students via text messaging and other examples where students and tutors had cooperated using text messaging were to be found in the Department of Computing. Interestingly these used other text messaging provider services and not the central MCAT system. This points to how inexpensive it is to start text

messaging students and without any coordinated strategy (some free services exist or some will allow free trial periods). However, a proliferation of solutions can evolve.

In 2008, the university bid successfully for national funding under a research programme designed to explore institutional responses to emerging technologies. The idea behind the project was simple: connect the announcement feature in the VLE (Virtual Learning Environment) with text messaging so that certain classes of announcement could be notified to the student by text or RSS feed. At that time, students had to log in to the VLE in order to see any announcements and hence have to poll the VLE regularly to get updates. The project (known here as VLE) was to be a trial involving students in different faculties: Law, Biology, Computing and Business. The main focus of the project was to allow tutors to place urgent announcements onto course pages on the VLE, which in turn would be converted to SMS and sent to a subscribed list of students. Urgent announcements were classified as events such as lecture cancellations, room changes but also could extend to events like reminding students of assessment submission deadlines or telling them when marked assignments could be collected. The value of this classification was verified with students through the trial (through a survey). As well as providing an SMS option for urgent announcements, the students could also subscribe to RSS feeds for all course announcements, whether these were urgent or not. The expectation was that that the majority of students would view the RSS feeds through a portal such as iGoogle but those with smartphones/PDAs would also have the possibility of viewing the feed on their mobile device.

Finally, there was a service introduced by the students union (known here as NOSHOW). Its aim was to supply a text number where students could report occasions when they had turned up for a lecture/tutorial only to find it wasn't happening. Information from this service was then passed to faculty heads on a monthly basis. Although the motivation for this service was different, including the reporting of occasions where tutors had failed to show, there is considerable overlap since many of the messages would refer to situations where a room had been changed or a lecture had been cancelled and the student hadn't seen any notification of this.

Yet another service appeared during the course of the field research. The university decided to change its email system from an in-house supported solution to an outsourced service hosted by Microsoft with its live@edu offering. This also offered the potential to deliver text messages to students based on a user-defined filter. In other words, students could choose to have some messages delivered by SMS. This service appeared after the field research was completed so it is not included in this analysis. Nevertheless it illustrates the range of options that need to be considered if developing a text messaging strategy for the whole institution.

Against this background of these potentially overlapping and competing services, there were efforts by the university to improve student experience and text messaging was seen as one method of achieving better communication. There is

no doubt that not being aware of events, such as changes of room, led to negative feedback in student satisfaction surveys, especially the National Student Survey (NSS) which was the benchmark by which the university was nationally measured. However the university was cautious about embracing text messaging on a wider-scale since there were perceptions in the university executive that students frequently changed their mobile phone numbers and thus text messaging might prove no more effective than other channels. Thus communication with students is another area where there may be some form of link between central communication policies and these localised initiatives; a link between the 'global' and the 'local' in ANT terms (Law and Callon, 1992, p. 26).

6.2 The Research

Ten people were interviewed over a period of two years on text messaging projects. These ranged from tutors to student union representatives, members of the university executive, IT services and university telephony providers. In addition, some comments were extracted from surveys the university conducted on students that included questions on text messaging. The transcribed interviews were examined for themes and interview scripts were coded using a qualitative analysis tool called Hyperesearch™. Essentially this assisted the task of reading through the transcriptions and highlighting significant quotes and themes and giving those highlighted excerpts a tag. The qualitative analysis tool enabled looking at duplicate tags or related tags so that significant comments could be combined into a smaller number of tagged themes. Essentially, this represented in grounded theory terms, the stages of open and selective coding (See Section 5.8). Open coding was the tagging of themes and selective coding

represented the process of refining these themes into a theory. The first analysis task was then to explore the tagged themes and discuss their implications with respect to the innovation and mobile learning literature. Following that discussion an attempt would be made to model the scenarios in terms of ANT and Law and Callon's global/local model.

6.3 The Analysis

Broadly the findings fall into four major categories that are discussed in turn below. These relate to how the university communicates with students electronically, how value is demonstrated in the new services, what the levels of staff and student engagement are with the concept of text messaging and lastly how does the structure and strategy of IT provision impact on the service.

***Communication*.** This looks at when it is appropriate to use text messaging as a form of communication but also interestingly who controls that communication and whether there are ethical implications about its use. The university has traditionally communicated with students electronically through the student email system but this has become increasingly unreliable initially through students preferring to use their private email addresses for any email interaction and more recently through a trend for students to use social networking tools such as Facebook for their person-to-person communication. As one tutor summed up:

> " We don't rely on email because we are aware a lot of students don't look at the student email account" ***Tutor***.

There was notable concern amongst tutors about how students found out about certain events and the tutors' awareness of this. Several examples were given where students would ask tutors whether they were aware of a particular announcement and the tutors would have difficulty in tracking down who had originated the message. In short, they wanted to be well prepared for questions from students about change to particular events/ schedules and didn't want to spend time digging around to find the originator of the message. Text messaging just added to that concern –

> "I think part of the problem these days there's just so much information" ***Tutor***.

It was felt that if there was one place where messages could be displayed and delivered from then that would ease the communication problems. Often faculty offices may send text to students but tutors would have no reference to these messages:

> "Because there was this possible conflict in messages going out from faculty and messages going out from the VLE and nobody knowing who was responsible for what" ***Tutor***.

This can leave tutors in a difficult position –

> "what tends to happen is that a student will say to you I've had a text about so and so and you have to say well I'm sorry I've got no idea who would have sent you that text or what it means or why they're saying that" ***Tutor***.

One could assume that tutors are looking to control communication with students but they deny this, they just want to be able to see all the communication via a central point, the VLE being the obvious candidate to manage this –

> "not that we'd want control but it would be nice to know what they were saying but we don't tend to get told other than when our office manager

> manages to find something out and then she passes it on to us" ***Subject Lead Tutor***.

Tutors are looking to see a policy or strategy so consistent communication is achieved to all students and they can always be informed and also know how and when to use particular communication methods –

> "a clear communication policy about what sort of messages for what particular type of communication" ***Subject Lead Tutor***.

Getting communicating right was a priority for the university and was a source of negative feedback in national student surveys. Text messaging could just exacerbate the problem as it presented another opportunity for inconsistency illustrated by this comment –

> "I was extremely disappointed as I received no text messages despite several tutorials being cancelled or room changes. The only text I did get from Uni was about paying fees. This showed that the Uni was more interested in making money rather than providing a genuine service" ***Student***.

There was widespread agreement amongst tutors, managers and IT service representatives that text was not the panacea to all communication problems. All parties agree that there has to be an alternative for those who choose not to use text or who do not have access to a mobile phone –

> "can be a bit messy because you can have somebody posting an urgent message and there'd be no text back up and somebody posting an urgent message and there would be a text, and then you've got the possibility of students then saying, well I just rely on text for urgent messages and I wasn't texted" ***Tutor***.

Also tutors and service providers acknowledge that they cannot assume all students have access to a mobile phone as it's not mandated by the university and they must also recognize that student may lose their mobile phones at times –

> "there will be people who have no phone that day or just had their phone nicked the night before…. there are all kinds of reasons why someone might miss something and therefore it can't be the only method" ***Tutor***.

There was also widespread concern over the ethical context of using a student's mobile phone for communication. Should the university assume this is acceptable or should they have an explicit opt-in or opt-out mechanism? Some students appear not to be too concerned by this, whereas others are very specific about their phone being a personal space –

> "I hate being texted by unknown things and bothering me, I like my phone to be used for the purposes that I have agreed it should be used for" ***Student***.

There are two approaches to handling this within the university's set of text messaging uses. In one system, the mobile phone number is taken from student enrolment forms whereas in the other systems student have to opt-in by registering their mobile phone number on a website. The advantages of the first approach appear to be that it would reach more students by default whereas the second approach requires students to be pro-active in their registration.

The university has considered the privacy issue and with the initial "MCAT" system had asked the legal department review the situation and -

> "had it written into the student registration forms that they could be contacted by text" ***Telephony Manager***.

The university is not that explicit about this during the registration process the view being

> "if they read the registration forms correctly, there is a clause in there" ***Telephony Manager***

and

> "they're accepting the fact that we can contact them by text and to opt out they have to tell their departmental offices" ***Telephony Manager***.

Data from a student survey would suggest that students don't really pay attention to this during the registration process so their "consent" is often a default rather than an informed choice. Still evidence is scant that many students have a problem with this and there is evidence that an opt-in service doesn't get the take up –

> "they'll see the benefit once they start receiving messages but to actively go somewhere and sign up for it, although it might only take, a minute it's just they see it as "I've got another little annoying thing to do that somebody needs, needs something out of me, why can't they get it already I've put it in my registration data" ***Telephony Manager***.

Other tutors felt that although there may be a very small number of students who would be concerned about the privacy aspects of this for the majority –

> "I don't think it's a principled decision to not opt in" ***Tutor***.

One further aspect of communication is that of students changing phone numbers. The university executive had reservations about the use of text messaging as they had a perception that students would frequently change their phone numbers as

> "we perceived that students often changed phones to keep up with the latest technology" ***Deputy VC***.

In a survey of 128 students, 85% expected to keep the same phone number after one year so the executives' perception was inaccurate. However that still indicates a problem in that over the average three-year course there was the potential for a third of students to change their numbers. IT services admit that

> "enrolment data gets out of date, so you are going to be missing some students" ***IT Services***

and that

> "this was something they looked at initially" ***IT Services***

but had yet to come up with a satisfactory solution. It was widely accepted by tutors, administrators and IT providers that students may not be pro-active in updating their registration information. This was one rationale that some tutors were keen to see text messages delivered through the VLE as at least then they could point to a single place where all relevant messages could be found, even if the student chose not to receive any of these by text –

> "I like the idea of all messages to students going on the VLE even if some of these get delivered by text as well, that seems a more cohesive system to me" ***Tutor***.

Tutors were wary of the MCAT system for fear that important messages might not reach the students as they too had the perception of a constant churn in mobile phone numbers,

> "I mean how many of them will change their number during the year, loads of them" ***Tutor***.

Demonstrating Value. Having discussed the issues surrounding coordinated communication, are there actually strong requirements to text message students? In trying to find out how the projects had been initiated it appears that the requirements originated from the perception that students would respond and engage with text. According to IT services the requirements came about through numerous ad-hoc requests of the form:

> "people were asking, can we text, can we text from email etc.…" ***IT officer***.

There was also some input from students:

> "we've got a very limited bit of feedback and I can't think where it came, where it was from some part time students who were really enthusiastic about this***" Centre for Learning and Teaching.***

And another tutor recalling discussions in lectures:

> "we have had discussions about this, they're all sort of keen on the idea" ***Tutor***.

Some tutors also considered the cost benefit analysis in trading off the cost of sending out messages versus the potential disruption and cost of informing students about changes in other ways:

> "Compared to the disruption that it causes even if it was still 10p a message sending it out to forty students would be £4 and it's much more than £4 worth of effort of somebody's time to go out and tell people about changes, or to stop the complaints coming about you never told us" ***Tutor***.

It is more difficult to assess the value of the service. All of the feedback is anecdotal although there are many examples where it has been effective. IT services admit that there is no official survey on use of text messaging and they haven't attempted formal evaluation:

> "So we have never done any feedback forms or surveys with our text messaging system" ***Telephony Manager***.

However, anecdotal evidence from different groups of users suggests it has been effective. For example, the art and design faculty used the system so that students return equipment such as cameras which they loan from the university for project work –

> "the admin people are saying that they're finding more response back; they are finding more response back to them than they did with a letter or email" ***Telephony Manager***.

Use of the service appears to be sporadic with some faculties making significant use whereas others are not using the service at all. IT Services felt that there has been some perception that costs would be too high from some faculties but it also seems that some tutors and administrators were pro-active in seeking out this type of service:

> "I think it's been a bit historic, I think initially it was the cost, but once people use it this is less of an issue" ***Telephony Manager***.

More recently the university executive had supported the use of the service based on trying to combat issues of student frustration with university communication arising from the National Student Survey and other internal surveys of student satisfaction:

> "I think once the deputy VC pushed out his email to say that we've got this facility, and this is the way students want to be communicated from a student survey, then I think more people have come back and said well you know we'll put one or two people on it, we'll try it out" ***Telephony Manager***

However despite encouragement, the system remained sporadically used and usage is still light, taking the university as a whole:

> "we don't actually track usage other than to apportion cost ... ... I can tell you how many we've sent all told and it's not vastly used, put it that way". ***Telephony Manager***

One issue with usage is for students to see value in the service and it seems they don't see that unless an event occurs for which the text message saves them from a problem, such as travelling to a cancelled lecture. One tutor even remarked that the university should test out the service deliberately to engage the students:

> "it's almost worthwhile changing venue for the third lecture or something and sending a text about it" ***Tutor***.

It is perhaps significant that staff still view text messaging as a pilot service as IT services readily acknowledge:

> "Well it still is a pilot service as it were because we didn't know how it would be used, how it would be accepted" ***Telephony Manager***.

This reflects the fact that it seems to be embedded in some areas particularly for administrative tasks such as recalling equipment on loan or reminding students of fee payment deadlines, but is unused in many subjects.

In assessing the value of the text messages services, cost has been a dominant factor with many interviews relating that cost of sending messages was a concern of faculty or department heads. Some managers seem to recognize that the cost of sending messages is exceeded by the savings in staff time in sorting out students' problems and complaints. But other managers view the cost as an additional charge as staff time is already a sunk cost in their budgets. Billing seems to have been a major driver behind product choice, much more so than technical requirements. IT Services had chosen the MCAT solution because it offered the ability to pay after usage and allocate changes to individual departments, a key driver being to ensure costs were not placed on central IT budgets:

> "The other vendor was a pre-paid web based product and MCAT was a post paid product so that met our needs" ***Telephony Manager***.

But the MCAT service couldn't be used from within the VLE as it didn't have a programmable interface but this wasn't a factor in the original procurement:

> "but that's not the way really we wanted to work, we wanted to allocate certain amounts to certain departments" ***Telephony Manager***.

The differing requirements of cost model and technology capability have driven different parts of the university to adopt different solutions with no evidence of a common strategy, which can unite all the requirements through a single solution. This presents a significant barrier to embedding text messaging as a service and tempts different groups into the formation of separate local networks which might otherwise be a single network which translates irreversibly into a common global solution (Callon, 1991).

Engagement. In the initial field study (Chapter 4) consisting of 10 universities, there was anecdotal evidence of staff resistance to the use of mobile technologies. The research into text messaging looked for evidence of this and also tried to gauge the level of student engagement. Generally staff seemed to like the idea of text messaging students about certain events but there was no agreement on whose responsibility this should be with some looking to administrators to handle this role:

> "It's not our job to do this, it's not the job of an academic if we are sick and we are at home there is no way we should be expected to log into a computer on our sick bed and send a message to students saying that a class is cancelled" ***Tutor***.

This is contrasted to the idea of VLE announcements appearing by text. Staff normally retain responsibility for putting announcements on the VLE and don't expect or necessarily want administrators to do this. There is a strong link back here to the discussions on communication strategy and solving the problem of having one place where students receive messages.

As for students, they seem positive about using text and are genuinely pleased when it saves them effort or unnecessary travel. –

> "When I've used it for my announcement I got really positive feedback and girls stopped me in the class and I wasn't expecting it, actually she said, 'I just want you to know I really appreciate the fact that you texted us'" ***Tutor***.

Where the service was opt-in through the VLE, only around 15% of students registered their phone numbers even though over 80% of students surveyed claimed they would like this service. This goes back to the debate on whether all students get texted or whether it's optional.

Links to IT Strategy and structure of IT provision. The final area of discussion that emerges from the interview data is that of how IT services is structured and how text messaging links back into a whole IT and communication strategy. There is a separation of those who look after the IT infrastructure, those who look after telephony and those who look after learning technologies such as the VLE. Although eventually there is common senior management, this separation of functions appears to be an issue when dealing with something like text messaging which may rely on the support of all three areas. There was already some evidence of disjointed thinking in IT provision in HE from some earlier research undertaken in preparation for this thesis at a different institution, which had looked at podcasting support (Bird and Stubbs, 2008). Initially IT services had not managed the introduction of podcasting, seeing it as not "core business". As podcasting spread from tutor to tutor, many downloaded podcasting software from the internet and gradually the university servers filled up with draft podcasts and the whole university intranet eventually failed as it ran out of disk

space. This highlighted both the lack of mobile technology strategy and that the structure of IT service provision may also be a barrier to its introduction. Thus this research into text messaging was informed by this prior research.

At the time of this research, there was re-structuring in place in the university IT Services and the area of telephony was divided between infrastructure (e.g. phone circuits) and production services (such as voicemail). This leads to some boundary issues, and one area at the boundary is text messaging. As one IT telecoms representative put it:

> "it's going to be very much a joint effort between us all" ***IT Support***.

To be fair to the institution involved, there was some recognition by IT management of the need to bring some services together:

> "It's moving more towards the Unified Communications. Voicemail, email, text messaging and video conferencing all being supported through one strategy" ***IT Manager***.

The problem of a unified strategy or joined-up-service is best explored through the proliferation of text messaging services that the university has in place. Earlier discussion has already highlighted the fact that there are two services within the IT umbrella, the MCAT service and the VLE based service. It was also apparent that some faculties had experimented with text messaging on an ad-hoc basis and the university's new student email system (live@edu) had a capability to turn certain categories of messages into text, opening up the possibility of students directing email into text messages themselves. Coincidentally the student union also announced its own text messaging service known as NOSHOW whose aim was to give students the capability of sending a

text when one of their tutors was either late in arriving at a lecture or the class was cancelled without any prior notice. The student union would then feed this data to senior management with the aim that such incidents would be investigated and rectified. Although there was a different emphasis on this student union service, all the services had in common the aim of reducing instances where students travelled to a lecture or lab to find it wasn't taking place. So was this a case of 'competing translations' (Callon, 1991, p. 159) or were these all part of a joined up strategy supported by senior management and IT services?

The NOSHOW service illustrated issues of a joined-up strategy. Tutors were concerned about the existence of the service and what actually happened to the information being sent in by the student union. Could management use the information in a sensible way? There was angry reaction from some tutors to students reporting them for being LATE –

> "I think this created a potential them and us situation in the way it was portrayed" ***Tutor***.

It was also greeted with some surprise given it was the practice for many students to enter lectures after the start:

> "I can think in eleven years on the fingers of one hand the number of times that something has not run because somebody's fallen ill etc., so we don't have that as an issue and I saw that, and thought bloody impertinent. You know about students turning up late, so that was my response and yeah staff cancelling classes and classes not running is wrong and it shouldn't happen, unless there are real circumstances where somebody's ill" ***Tutor***.

However tutors accepted that they had a right to do this and that they had a professional responsibility to attend on time or make arrangements so that

students would not attend cancelled lectures. Many thought that instances were rare and one commented that the students' union statistics reflected well on a university of this size and complexity –

> "Personally I thought that the number of complaints they have… bearing in mind the size of the university, I thought it was tiny" ***Tutor***.

A member of the executive had participated on a national radio show talking about NOSHOW with the student union president and this had caused some consternation amongst staff:

> "I appreciate the Students' Union is independent and they're entitled to do whatever they want to do to find out the scale of the problem but I think the university needs to be more proactive than just going on radio alongside the Students' Union and saying oh yeah it's a great idea, no actually you're the employer you do something about it." ***Subject Lead Tutor***.

Staff also pointed out that there was no link between the students' union reports and the steps that a tutor might take in letting students know about changes although it was assumed that Deans and heads of department would investigate this:

> "We don't really know what's happening with it or what is being crossed checked about it" ***Subject Lead Tutor***.

There was no link back from the NOSHOW data to the official university MCAT texting system and the administrator confirmed that no data had ever been sought from the system to check on whether text messages had been sent out which students had ignored and still complained through NOSHOW:

> "Well you've got a comparison with it because I'm the overall administrator and by looking at certain people's messages I could check because there's only me at the moment that can look at the messages and nobody's asked me to do that" ***Telephony Manager***.

The NOSHOW service was not introduced with the aim of highlighting specific instances where a tutor had failed to appear but was designed to demonstrate the frequency of the problem to the university executive:

> "We just wanted to find a way to show the overall extent of any problem, we would expect individual cases would be dealt with through the student course rep system" ***Student Union Officer***.

The university executive confirmed this approach:

> "We welcome the data from the students union and it's a high-level measure of the extent of any problem – it's passed to heads of department to investigate specific cases" ***Deputy VC***.

It's also interesting to note that the student union system used yet another commercial text messaging system to send messages and not the university MCAT product. The students did approach the university to see whether they could use MCAT but this didn't materialise:

> "Well I was actually asked by the Students' Union could they use our system for this And when they told me what it was for, I said it's a bit political this I think you'd better speak to someone in the Executive and I put them in the direction of xx but it never went any further" ***Telephony Manager***.

The issues with communication strategy and the fact that text messaging wasn't in the core IT strategy led to this situation where a number of solutions were attempting to solve similar problems with no coordination between them and that this was also leading to a proliferation of text messaging service providers. The next challenge is to examine this using ANT to see how effectively it can model this scenario and start to develop a theoretical contribution.

6.4 An Actor-Network Theory analysis

In Actor-Network terms, the proliferation of solutions in project SMS, none of which can claim to be the institution-wide offering, is a case of competing translations (Callon, 1991). It appears to be a case of divergent requirements that are not being translated into one set of unified requirements that can be accommodated into one solution. The next diagram (figure 5) looks at the competing requirements:

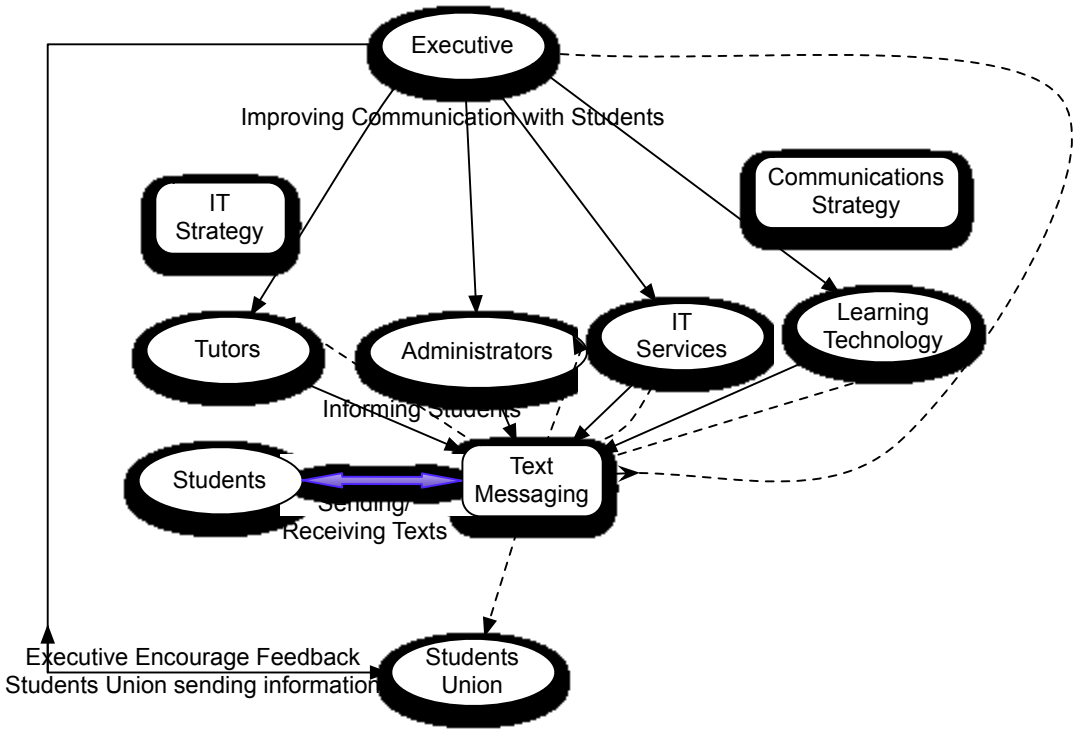

Figure 5: Actors in the university "global" network

Looking at the interests of each actor, evidence suggests:

The Executive. Wants to improve student experience and avoid situations where students fail to find out about cancelled or changed lectures. Attracted to text messaging but concerned about costs and the churn rate in student mobile phone numbers. Broadly supportive of student union text messaging initiative but may not be getting enough management information it can use to rectify problems.

Administrators. See text messaging as a means of getting information to students quickly. Want an easy-to-use package which enables this and clear guidelines of how to send out messages in certain situations.

Tutors. See text messaging as a new channel for connecting to students but need a policy of how and when to use it. Some are suspicious of student union text-messaging project as a means of "rat on your teacher" as opposed to a feedback mechanism on effective communication.

Learning Technologies Responsible for the VLE and see text messaging as a useful extension to the service. Not directly involved in other text messaging initiatives.

IT Services. Having some control over one of the systems (MCAT) but see this as a trial or add-on, not a core service. Associated with telephony more than IT provision

The Student Union. Keen to give the executive feedback on student experience but understandably wants to remain independent of university-provided services.

Interested in using the same technology platforms for cost purposes but not able to achieve this.

Students. Appear to be enthusiastic towards text messaging but aren't necessarily engaging with the university initiatives in large numbers.

Text messaging technology. In Latour's sense, very much an actor in the network. Easy to use and inexpensive to procure, it "encourages" a proliferation of solutions.

IT Strategy. Contains elements of telephony, the VLE and general ICT provision but no explicit strategy for text messaging.

Communications strategy. Not a single document or person but a series of policies and procedures. There are policies on areas such as student email but no policy on text messaging.

This has led to the next diagram (Figure 6) that shows that subsets of these requirements have led to the three different "local" networks.

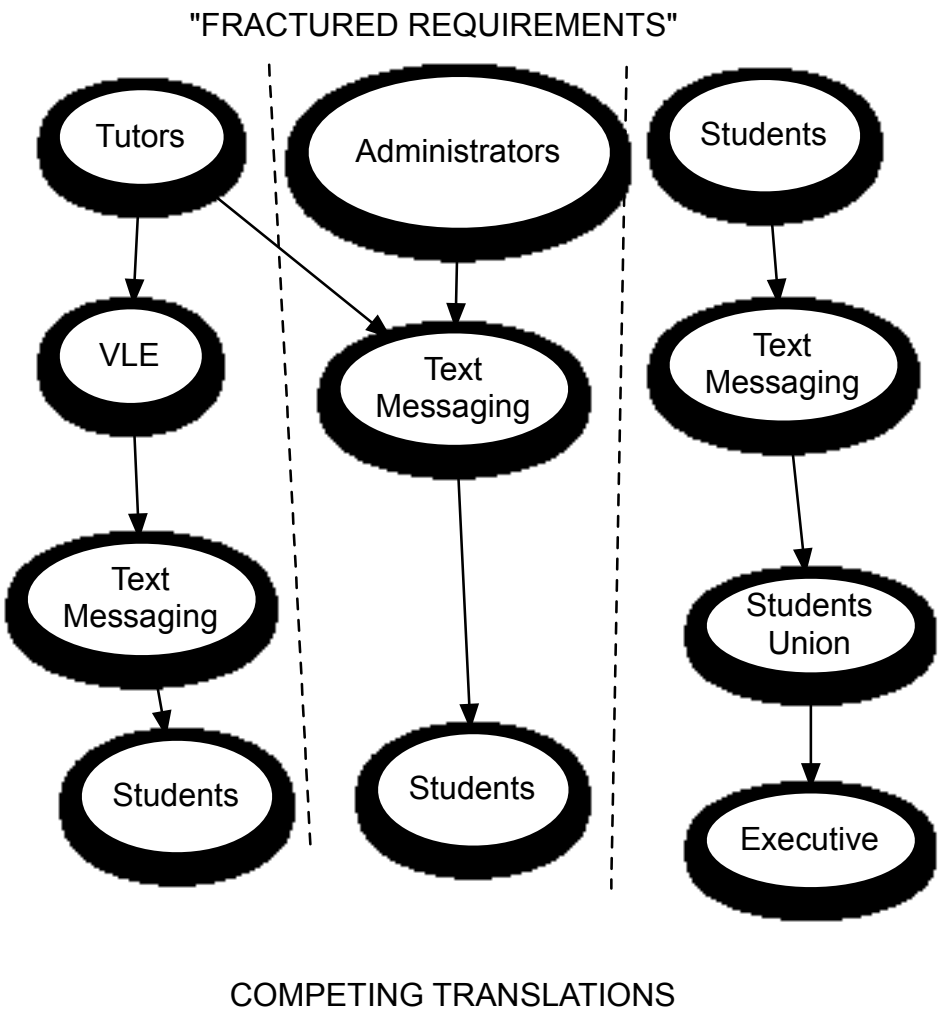

Figure 6: Competing translations leading to divergent "local" networks

The diagram (Figure 6) demonstrates a situation where all of these requirements can lead to divergent solution because in ANT terms there is no one place where they come together into a single strategy, an obligatory point of passage. Each instance of the actor "text messaging" represents a different solution to providing a text messaging service. It is relatively easy to create an independent solution regardless of any Executive or over-arching IT strategy that might exist. Perhaps an IT strategy and communication strategy that had clear policies on text messaging could act as a point of passage and exert some control over local

solutions but at the time of this research, these policies or mechanisms were clearly absent. Without such a point of passage the solutions could continue to diverge and indeed multiply as different parts of the university look to use text messaging. For example, finance may use text messaging to remind students of tuition or accommodation fee deadlines and the library was considering its use in sending reminders of overdue books. The university is also split across several sites and thus vulnerable to independent solutions.

Whilst the traditional ANT approach of looking at competing solutions holds true, how would this situation look if applying Law and Callon's global-local network analysis approach? In their study of failure of a military aircraft project, they identified factors that impacted on the embedding of the solution. This was an attempt to represent what they term a 'translation trajectory' (Law and Callon, 1992, p. 46) to describe the processes which iteratively generate them. They identify three factors that determine the shape and fate of technological projects. The first is the capacity of a project to build and maintain a global network that will at least for a period, provide resources that will support that project. The second is the ability of the project to build a local network, which can use the resources available in the global network to offer a solution that can embed to that global network. The third is the link between the two, the ability of any one solution to impose itself as an obligatory point of passage between the two networks. Law and Callon developed a model using these factors and represented it in diagrammatic form so it is possible to describe the 'translation trajectory' (Law and Callon, 1992, p. 47) of a project. The relative position of a project in the trajectory is a combination of the strengths of the two main factors

– capacity to build and maintain a global network and the ability to build a local network. If both factors are high then the project is likely to succeed and establish itself as a point of passage and thus become an embedded solution. The next diagram (Figure 7) is a graphical representation of their model (Law and Callon, 1992, p. 49).

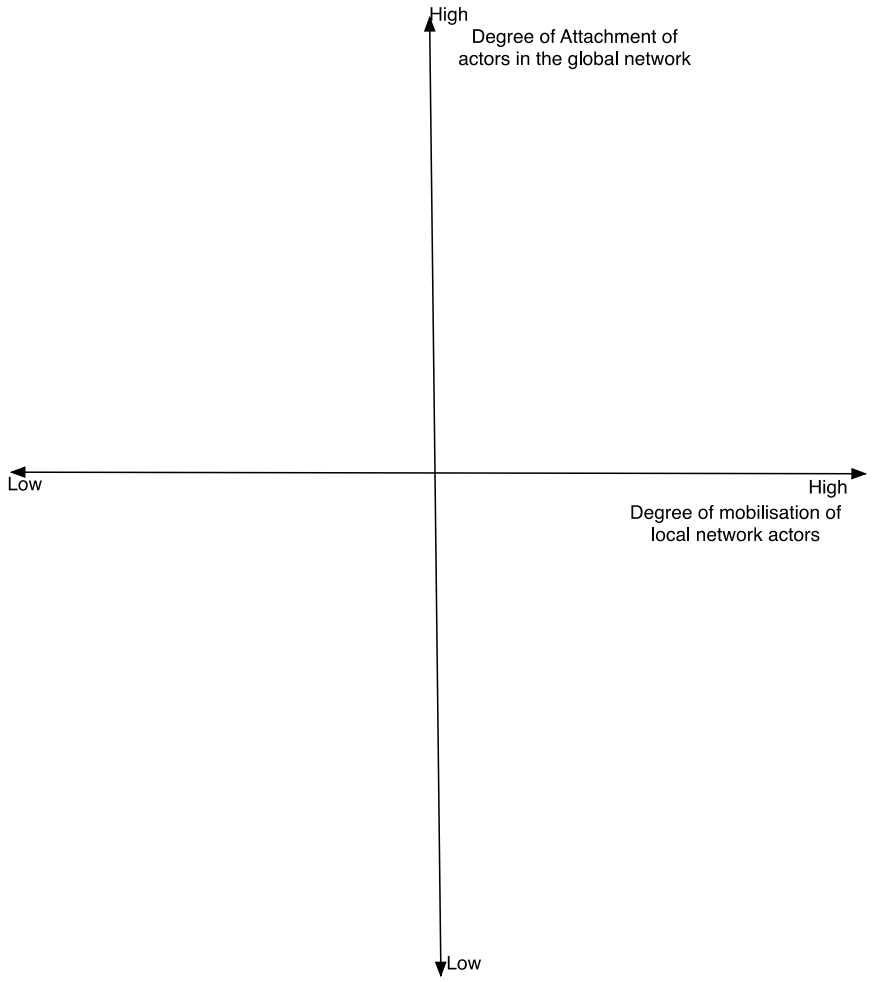

Figure 7: Law and Callon's graphical representation of global/local strength

It should be possible to plot the text messaging projects using this model. But there is an immediate curiosity about these projects as they seem at least in part to have some global support and additionally they seem to have strong local support in that they are likely to embed even if that is within a specific faculty. But it's also clear that none are managing to fill the purpose of a strategic solution to text messaging and it cannot be efficient to have at least three information systems fulfilling similar roles with the continuing possibility that other localized solutions could develop. There is plenty of evidence from the field data to show that staff are confused about these systems, students are also confused and receive inconsistent communication apart from the obvious duplication of effort and cost.

To examine the text messaging projects it is worth looking at the trajectories of them using the Law and Callon diagram above. To do this we identify key issues/events in the life of the projects and then reflect on the global and local support at the time those key issues were identified. Each project is represented through a single diagram.

6.4.1 The MCAT project

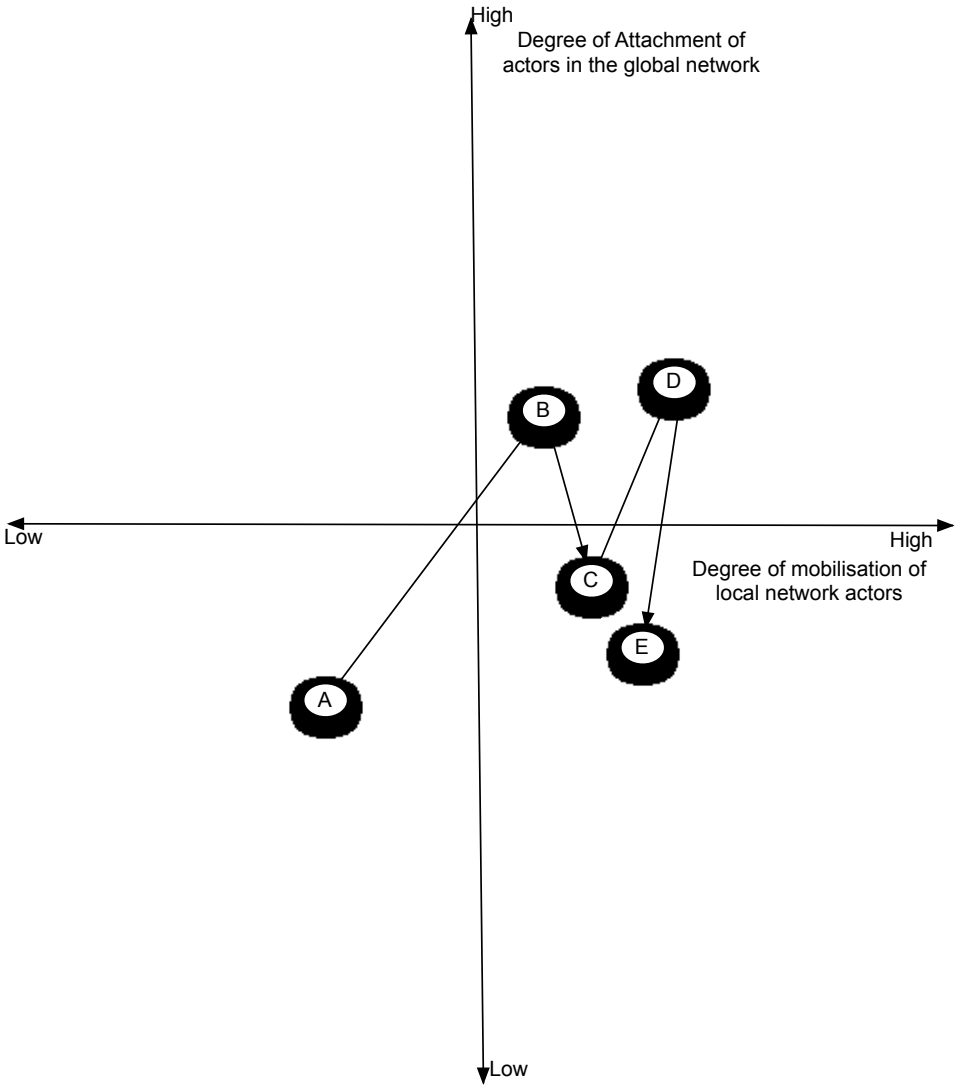

Figure 8 Actor-Network trajectory for MCAT project

	Event/decision	**Local consequences**	**Global consequences**
A	Initial idea	Came from Centre for Learning and Teaching and knowledge of what other universities are trying to do	Not involved initially
B	Investigation	Very much driven from the telephony side and not from any widely debated requirements	IT Director involved in procurement. Key requirement is ability to levy charges on individual departments
C	Pilot service	Available to all but usage highly localized to specific departments and staff	Sporadic encouragement from executive but not a strategic service

	Event/decision	Local consequences	Global consequences
D	Executive push	Some increased usage but still sporadic.	Executive send out all staff emails to encourage usage. Driven by NSS results to improve communication with students
E	Continuous Service	Usage grows but only slowly and is highly-localized i.e. many departments/faculties do not use it	Occasional encouragement by executive but no attempt to embed at a global level.

Table 5 – MCAT Project Stages

The above diagram (Figure 8) shows the different stages of the MCAT project using Law and Callon's trajectory diagram and the table (Table 5) identifies the key events in the establishment of the MCAT project. The project has some support in the global network as there is occasional encouragement to use from the Executive and the service is supported through the central telephony team. Usage does grow with time but in a sporadic pattern and whilst simple to use it's clear that some staff would prefer to see messages directed via the VLE so that they have one central point in which to manage student communication. The service remains optional so it never becomes a core service that students can expect to see as part of their communication with the university. In other words it never establishes a clear point of passage between the service and the overall IT and communication strategy.

6.4.2 The VLE based project.

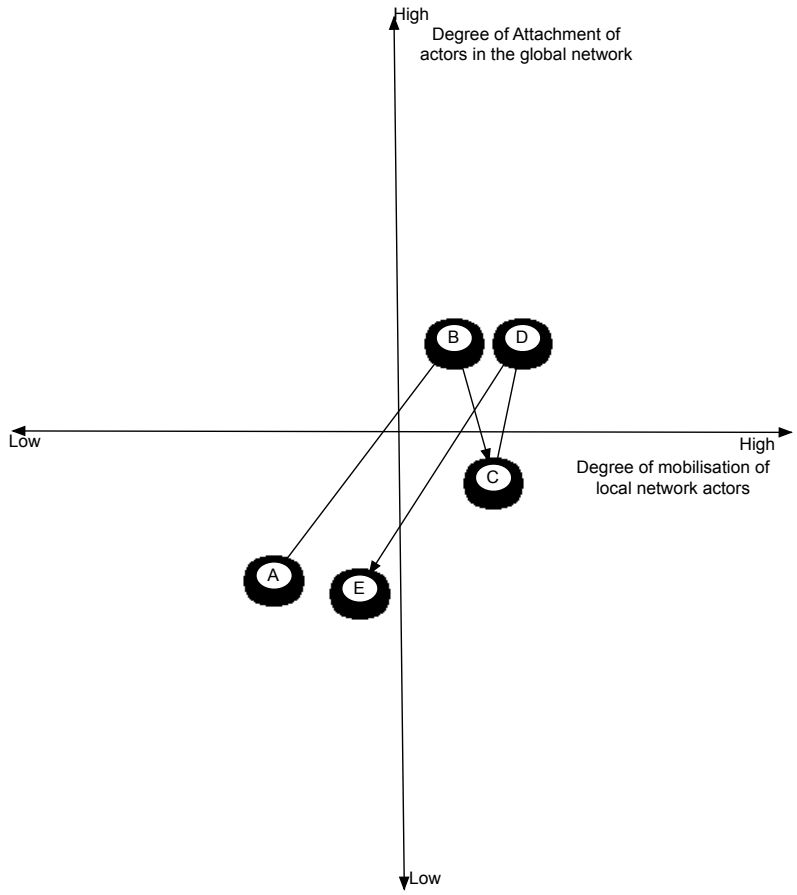

Figure 9: Trajectory of VLE based project

The sequence is explained through the following table:

	Event/decision	**Local consequences**	**Global consequences**
A	Initial idea	Staff interest in communication through VLE. Learning technologies review.	Not involved at this stage. But VLE is a pervasive technology in institution with executive support
B	Partial Funding	Ability to experiment with the technology.	Executive support for funding bid but no support from a strategy viewpoint
C	Technology choice	Able to proceed with pilot but with different technology choice.	Another technology in play leading to competing and divergent solutions

	Event/decision	Local consequences	Global consequences
D	Pilot service	Some sporadic usage which is well received by students	MCAT solution still favoured choice but no review of strategy
E	Stagnation	Project ceases when funding period expires. Continued interest from learning technologies group but no link to overall communication or IT strategy at this stage.	No university-wide push to support text messaging through the VLE.

Table 6 – VLE based project stages

The Law and Callon diagram (Figure 9) and corresponding table (Table 6) identifies the key events in the VLE based project. The VLE is a core technology in the university and its usage is almost universal across all courses. Staff are attracted to the idea of using the VLE as a place to post messages that would then be texted to students as it gives them one central place to control student communication. The pilot service attracts some external partial funding which allows a trial to take place across a small number of subject areas. The technology choice is the most interesting stage from an ANT perspective. For software interface reasons the alternative MCAT service can't be used to create this VLE service and hence a different technology is procured for the trial. The pilot proceeds but there is insufficient momentum behind the service so once the trial is over the service stagnates and becomes disused. There is still considerable support for having text based communication via the VLE and the learning technologies team hope to resume the service at a later date.

6.4.3 The student union NOSHOW service

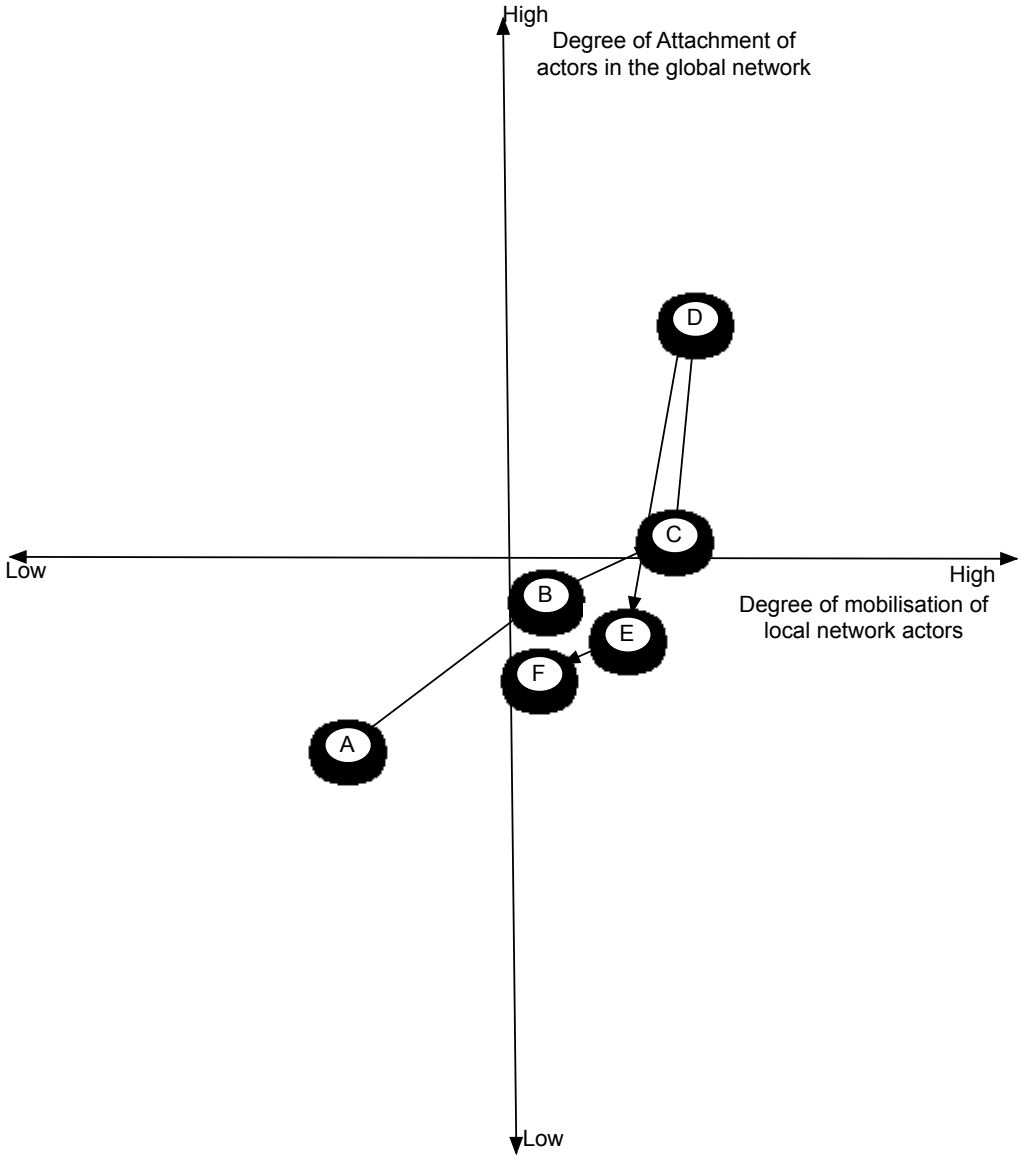

Figure 10: Trajectory of NOSHOW service

This sequence is explained through the following table (Table 7):

	Event/decision	**Local consequences**	**Global consequences**
A	Initial idea	A response to student complaints about staff being late or not turning up for lectures.	Executive concerned about poor NSS scores but no central strategy to tackle these issues
B	Technology Choice	Students union ask to use university MCAT system but fail to make progress due to political reasons	Yet another text based service and opportunity to join up information systems lost.
C	Launch	Service widely publicized through faculty notice boards. About 200 messages sent in in first few months.	Executive receive data from students union and say they will act.
D	Executive Support	Students union build support with executive	Member of executive goes on national radio with students union
E	Staff Reaction	University staff unhappy with way service has been presented although keen to emphasize student union is independent	University-wide staff anger and trade union complaints. Staff/Student/Executive relationship strained. No sharing of information so staff not aware of how student union data is handled.
F	Ongoing Service	Continues to run with a lower profile	No attempt to integrate with other services and no influence on IT strategy.

Table 7 – NOSHOW project stages

The service is launched in response to a perceived need from the student union. The union attempts to use the same technology as the university but is unable to get agreement on this as university staff fear this will become 'political'. The service is launched via a widespread poster campaign and students start to send in messages. An executive member appears on national radio with a students' union representative and is supportive of the initiative. Staff reaction is a mixture of anger and frustration and a feeling that the problem is not that significant given the size of the institution. Staff have no access to how this information is

being handled and it appears as though it is not diagnostic enough to track down specific problems other than to make management aware that there are issues within a particular department or subject area. There appears to be no link between this system and others that the university has, so staff suspect that there is no safeguard against any misuse of the system by students. Staff trade unions send out emails complaining about the NOSHOW service. The furore dies down and the service continues but slowly drops off the agenda for both staff and senior management.

6.5 Reflection on Issues raised

There have been many trials of text messaging in Higher Education ranging from interactive language teaching (Markett et al., 2006, Kukulska-Hulme, 2006) to administrative messaging which is similar in nature to solutions examined in project SMS (Naismith, 2007, Nix et al., 2007, Riordan and Traxler, 2005, Brett, 2011). Naismith (2007) states that reminders of assignment due dates, lecture cancellations and room changes were seen as appropriate text messages by students but that students were slightly wary that the university might use SMS to bombard them with advertising for campus-based services. Interestingly the students in this earlier research appreciated that the text messaging was a one-way service and that they preferred to use email to send in their own queries. Administrators also felt that students didn't check their university email accounts regularly but SMS was a better way to ensure that the announcements were received.

Traxler and Riordan (2005) in their study of bulk targeted SMS at the University of Wolverhampton also report that students were positively disposed towards SMS to support their studies. They also acknowledge that there might be different types of system employed from applications that are standalone SMS texting systems through applications that offer SMS delivery as a feature to components that integrate SMS into other applications. They also refer to a number of institutional issues with scaling up these trials into campus-wide services such as the impact on those not having a mobile phone (inclusion), the business justification and cost of scaling up an SMS service and ethical issues such as how the university stores and uses the students' mobile phone number (Riordan and Traxler, 2005).

Reflecting on this earlier research, some of these existing findings are confirmed by evidence from project SMS. Students seem to be well disposed toward the idea of using text messaging and broadly tutors are too. The system needs to be consistently used to have an impact so that value is demonstrated; students are easily discouraged if they don't see any messages which help them and can become alienated if their only experience is messages such as reminders of overdue payments of fees. Fears that an institution might exploit the text channel for marketing purposes (Naismith, 2007) seem to be unfounded and also fears of inclusion issues (Riordan and Traxler, 2005) don't materialise as mobile phone ownership is almost universal with the student population. Ethical issues are still present with a few students seeing their mobile as personal space reflecting some similar concerns that arise when education provision interacts with what may be seen as a personal space such as social networking (Traxler, 2010a) but this,

however, is a minority (Less than 5% of students in response to a survey within the VLE project). The issue of opting in to the service or being registered automatically is also an ethical issue and a practical one. Ethically, opting-in is preferred but automatic registration brings far greater penetration of student cohorts. However in either case there will be some churn of phone numbers and any system is unlikely to reach an entire cohort reliably.

Whilst these findings around the appropriateness of text messaging students largely augment earlier studies, using the lens of business information technology, innovation diffusion and Actor-Network Theory bring new insights hitherto only hinted at in the *m-learning* literature. At an institutional level, a lack of communications guidance or strategy seem to be an issue which concerns tutors, when to send a message and who is responsible being major concerns. It is in the area of IT provision that the issues get more sharply focused on the key themes of this thesis and an area where Actor Network theory can potentially give new understanding. Traxler and Riordan (2005) hint at some of these issues in the scaling up of bulk text messaging to students. The evidence from project SMS suggests a failure at institutional level to grasp the requirements for a text messaging service into a unified set which will form an institution-wide service. To be fair these services whilst supported by the executive at different times are seen as optional pilots, albeit that MCAT had been running for three years, but there appears to be no apparent process or point of passage which will take the service to the level of a VLE in terms of embedding.

An interesting aspect of the study shows that the IT function is split into several areas, such as learning technologies, infrastructure and telephony as well as other areas such as student record systems. Perhaps a lack of cooperation or coordination between different IT functions is an issue, and a feature of higher education which has traditionally encouraged departmental and faculty independence (Christensen and Eyring, 2011). Universities would appear to have sometimes arbitrary split between centralised and localised decision making, factors which can hamper innovation diffusion (Pervan et al., 2005, Burns and Stalker, 1961). A lack of unified user requirements is illustrated by the technology choice of the MCAT system whose choice was substantially driven by the ability to bill departments rather than by user convenience or integration with existing university systems. Lack of services which closely match user requirements is another factor which will hamper embedding (Malhotra and Segars, 2005).

The analysis of project SMS has shown that Actor-Network Theory and the Law and Callon local/global model is a suitable lens to look at the projects and their cycle of progress. Project SMS seems to be a particularly interesting example in that it shows a number of competing translations, none of which would appear to look like they will embed in the fullest sense. But to some extent the translations defy Law and Callon's model in that they are able to continue without having the apparent support of the global network. In an IT sense, the lack of a powerful point of passage between these solutions and central IT strategy allows the potential not just for failure of local networks but potentially a worsening situation where local solutions can proliferate into a chaotic mix which both

confuse the end-user and waste resources. Of course such a situation does not necessarily apply uniquely to *m-learning* but one unique *m-learning* difference is that overall IT strategy appears confused between treating a mobile phone as a computer or treating it as a telephone. Best practice in procuring computer-based IT solutions will give user needs a prominent role (Venkatesh and Davis, 2000) whereas mobile telephony procurement has been driven by cost especially charges for call-time, text messaging and data. There are indications in more recent reports that this dilemma facing Higher Education of how to integrate the smartphone or even tablet computer into IT strategy is a new challenge for institutional IT departments (Johnson and Brown, 2012).

Other features of ANT are also prominent. The idea that objects can be actors in the network is illustrated by the availability of text messaging technology. It is relatively simple to find a piece of software or a service that will send texts so the danger of multiple services is prevalent in the easy appeal and availability of the technology. The absence of the actors of "IT strategy" and "Communications strategy" within the network also explains why a point of passage doesn't dominate which would allow one or a combination of the solutions to become strategy and policy. The separate translations operate in a vacuum where no unifying actor can evaluate and promote a solution. There are transient links between those that set the strategy and the projects themselves, such as the Executive support for the NOSHOW service or the sporadic encouragement from senior managers to use the MCAT service. But none of these are effective to bind any of the solutions to be part of established strategy and policy. In thinking about strategy, the issue of IT being split across a number of different

departments that include learning technologies, telephony and infrastructure, looks like an issue for *m-learning* as all three have influence on its usage. This might be an interesting issue to look at in subsequent case studies. The issue of the link between text messaging and communications strategy also stands out as a potentially common issue in UK HE.

6.6 Chapter Summary

The use of ANT to analyse project SMS has been tested using Law and Callon's global/local model. This seems to be both an effective way of looking at project progress and identifying reasons as to why *m-learning* is successfully embedded or fails to embed. But there also appears to be weaknesses in this model, which offers a potential contribution to knowledge in this area. The bottom-up generated solutions may fail to build strong links with the global network but they do continue due to the simplicity of the local networks which create them. Additionally only modest resources are needed to create these different solutions which are within the control of local networks, perhaps analogous to the potential for local learning technologies to be created using Web 2.0 solutions. A top-down initiative such as a government project is ultimately dependent on the support of the global network, as eventually it will be starved of the funds and the political will to continue (Law and Callon, 1992). However, these text messaging projects do not need the global network to maintain them at least in the short to medium term. They have a low degree of attachment of actors in the global network and a modest degree of mobilization of actors in the local network that is enough to support them. Perhaps this model can be adapted or extended to explain this type of bottom-up IT project? Might other factors such

as the structure of the university IT department or the degree of maturity of the IT strategy with respect to mobile, play a part? The analysis has at least shown the model is sufficiently appropriate and flexible to be worth developing. The next stage is to apply this to a more significant case, that of an *m-learning* project which was being implemented across five universities operating in a loose federation or cluster.

7. Project MED: Mobile Assessment and the five-university project

> "I used to describe this mobile assessment project as we decided we were going to fly to Mars and we could all envisage how to fly to Mars but actually once we'd bought the rocket I'm afraid it didn't get past the moon really" ***Project MED partner lead***.

7.1 Background to the project

Project MED was by far the most ambitious *m-learning* project in the UK HE Sector in both its partnership structure and its goals of all projects encountered through this study's field and literature research. It was a five-year programme which started in 2005 and ended (at least in terms of the original funding model) in 2010. It was funded by HEFCE and set up under its CETL programme (Centres for Excellence in Teaching and Learning). The aims of the CETL programme were to reward institutions (or groups of institutions) who demonstrated excellence in teaching and learning and provide funding which would further enhance that excellence. An evaluation of the programme can be found via the HEFCE website (HEFCE, 2011) . Many CETLs are partnerships between several institutions as is this specific *m-learning* case but others are single institutions. Over seventy CETLs were established across the UK although funding for the programme has now ended and such a large-scale programme is unlikely to be repeated in the context of recent changes to Higher Education funding.

The main focus of this CETL was not specifically *m-learning* but majored on how to assess students in practice settings and specifically on clinical placements

in the health sector. All five universities had some history of collaboration in this area and all five had cooperated in finding placements for health students – an essential part of their courses. At a regional level they were also dealing with the same set of health providers ranging from the Strategic Health Authority (SHA) to more localised Primary Care Trusts and Hospital Trusts. Supporting students in practice settings was a key and expensive part of the course being delivered and involved a lot of tutor support. There was a drive to look at competences in areas that were common across the sixteen health professions for which the universities offered taught courses, such as patient handling skills and communication. Whilst actual clinical skills would always remain distinct, these interpersonal skills could potentially be assessed using common methods. Such common methods also opened up the possibility of students being assessed by trained assessors from any of the sixteen professions, improving inter-professional working and assisting economies of scale. Indeed if the professions could agree on a set of common competences in these areas that then opened up the possibility of a common assessment tool being developed. The concept of competency maps was developed as a graphical illustration of skills using the idea of a circular representation, which was then expanded outwards to develop representations of each competency – rather like the layers of an onion. The graphical representation was the basis for a set of tools which would allow the competences to be assessed in a clinical situation. The competencies that were selected were ethical practice, communication and team working - competences which were needed in all health professions. These tools were to be developed in a variety of ways: as a paper proforma, as a web application and lastly as a mobile application which could be completed by both student and assessor in-

situ within the student placement work environment. The thesis will not focus on this development of common competency maps but on the specific part of the project that developed a mobile assessment tool.

The competency maps were merely one aspect of the purpose of developing a mobile application. Whilst some students would be placed in city hospitals where perhaps they might be given some access to IT facilities or might well be located close to their institution, others might be placed in remote rural health practices with little or no access to the internet. The institutions spent considerable amounts of time and money recruiting assessors from the various health professions and delivering training so that they could assess the students according to guidelines. There were therefore several catalysts for this project:

- A need to standardise assessments and make them much easier for clinical practitioners to complete.
- Ensuring that students had greater access to learning resources whilst on placement and encouraging them to record and reflect on their practice experience.
- Reducing the amount of time university tutors might spend with students on placement through availability of online evidence that tutors could review and thus allowing them to focus on students who needed greater levels of support.

There was also the whole potential of a mobile device in a clinical situation giving the students access to information whilst with the patient rather than having to refer to resources such as text books when back at home. To quote the overall director of the project:

> "if you ask a question for yourself then the answer you get or the learning that you do to understand that question and response stays with you rather than if we just send you out to read endless pages of the textbook - you never remember those things. But you can remember it contextually so they give you an example in medicine that says a student went to see a patient on a ward and one of the things that they had was hypertension (high blood pressure) and I was looking at what drugs they were on and thinking do these drugs fit with the British hypertension guidelines - I'll look them up when I get home. But the chances of me looking them up when I get home are reasonably remote. If I could just access the information at the bedside using a mobile device and could just check out what the hypertension guidelines are then that learning is more likely to stick" ***Project MED Director***

The mobile aspect of the project was always a key feature of the project but gradually came to dominate as it absorbed more resources, experienced a plethora of technical issues and attracted a lot of interest. Competency maps were a major achievement of the project but were not compelling in the same way that mobile devices are, attracting the attention associated with new consumer technology. The project was structured around a management steering group with senior representatives from all five institutions, and then a number of sub-groups which covered the design of the tools/competency maps, the IT group focusing on the mobile devices and application and groups looking at research outputs and ethical issues. There was also a project management office located at one of the institutions that looked after the day-to-day project management issues. Locally each institution had its own steering group which handled the project activities within that institution. One partner institution also hosted a support site which provided first-line telephone support for students using the mobile applications across all five institutions.

In addition to the five partner institutions there was also input to the project from two software service suppliers and a partner mobile operator who supplied the

devices and airtime. The five institutions cooperated as a cluster in the procurement process leaving the lead institution to procure the devices and agree contracts with the above software suppliers and mobile operator. The software suppliers regularly attended the monthly IT group meetings, although the mobile operator did not attend, and interacted with the lead institution through their normal customer service channels.

The partnership was very effective in making decisions and generally there was broad agreement on most of them. The main technology issues that arose are discussed later in this chapter but were broadly the decision of the funders (HEFCE) and the structure of the CETL financing strategy that forced procurement of all the devices within one fiscal year and meant that the partnership had to run with mobile devices that became increasingly out-dated as the project progressed. The other decision, which perhaps didn't suit all partners, was the choice of a specific E-portfolio supplier (and not a mainstream product such as Pebblepad) to provide part of the mobile application as some were already using competing products. However this was an inevitable problem that had no solution that could satisfy all parties.

The project officially ended in 2010 with completion of the CETL contract, but the partnership continued at least for a further year using funding from the Strategic Health Authority to support some central project management but largely voluntary effort from representatives of the five institutions. In terms of the *m-learning* application, there was no further funding for software

development and the partner institutions pursued divergent strategies in this area once the original CETL project was completed.

7.2 Significance of project MED to this research

From the description above, it is apparent that this is a large and challenging *m-learning* project and for those reasons alone is worthy of investigation. However it contains several significant features that presented a unique opportunity at the time of this field research:

1. The application developed was a complex one that would challenge the institutional IT structure and support. As such it would need to be developed so that students could authenticate using their university user names and passwords and potentially integrate with other university system such as VLEs, student email and e-portfolios. This is in contrast to project SMS where any department could set up a service for the cost of sending the text messages and without recourse to interaction with the university IT services.
2. The project ran an IT group that had representatives from all five institutions together with some of the technology partners. Apart from delivering the project and solving the numerous technical issues, the group has an explicit objective to look at how embedding would occur once the project had completed and the funding was all utilised. As an invited observer to the group monthly meetings, this gave the researcher a close insight into the relationship between those working on the project

and their institutional IT strategy and management – in effect observing directly how points of passage between the project and IT strategy were being formed within each institution.

3. The presence of five institutions, whilst increasing the complexity and effort of the field research, enabled a direct comparison of how these institutions differed in their response to embedding an identical *m-learning* application. This gave clarity to the issue of embedding, the main focus of this research.

7.3 Analysis of generic issues which arose during the project

7.3.1 Overview

Five institutions undertook the project and consequently there were many common issues in relation to the technology, the staff and students involved and the restrictions imposed by the clinical environments where the mobile application was deployed. As with the text messaging project discussed in the previous chapter, project SMS, the issues arising can be divided into major categories. A total of six major categories have been chosen in the coding strategy:

- Three categories are common with Project SMS, those of ***demonstrating value*** in providing these sorts of applications, ***engagement*** with the service and the ***links between this project and the institution IT strategy***.
- Three additional categories are brought sharply into focus by project MED. Unlike Project SMS, which presented no major technical

challenges, this project had a number of significant ***technical issues*** to resolve which arose from developing the application and especially from the security requirements that were placed upon the project by the clinical environment they were to be used within. The capability of a handheld device raises expectations that they can be used in a number of ways such as accessing university systems such as a VLE and other learning resources available over the internet so ***multiple uses of the device*** is a key issue which also links to the issue above of engagement and demonstrating value. Although in project SMS, institutions would be concerned about cost of sending messages this is a relatively simple price comparison as opposed to the complex issues exposed in project MED of how to intersect with mobile operator ***business models*** for supplying devices, airtime and data usage.

The next sub-section looks at these six categories of issue in detail and demonstrates evidence of their occurrence through analysis of interview scripts and other materials.

7.3.2 Discussion of generic issues

***Demonstrating Value*:** A key part of the partnership's goals was to show that the presence of a mobile device would improve students' learning and allow tutors to target their support more effectively by focusing on students who were experiencing difficulties rather than visiting all students by default. This is summed up by the following quote:

> " Clearly the mobile learning cycle of being able to use the device for assessment to be able to record something on it to be able to have the tutor use the device with the student, to be able to then send that

> assessment back to again the E-portfolio – that's what would demonstrate the value" ***Site Lead***.

And:

> "unless you've got the full cycle, the mobile device is just seen as a mobile device and not a mode of delivering learning" ***Tutor***.

And it's not just the ability to demonstrate this learning cycle, it's also justifying that the extra effort involved is worthwhile for both the tutor and the student:

> "They see this as an extra piece of work and potentially the students, the students who have engaged well with it can see the benefit of that extra piece of work because its actually helping them to think about what they're doing when they're out in practice - the tutors are wanting to know how much time they're spending on it because they would then be asking does that mean we have actually improved the student learning experience" ***Site Lead***.

Another added-value perspective is the opportunity for the five institutions to experiment and develop new learning technologies and get valuable input into future strategy:

> "But what has emerged is the opportunity to exploit the potentials of mobile technologies and what has been particularly exciting is the way in which we have been able to work as a group of universities with industrial partners for that technology. Exciting but frustrating because there have been lots of technical problems which have caused some major difficulties for the project but at the same time I think it was moving us into a different ball park where suddenly we were working jointly with technological partners to think about creative solutions to support student learning, so that's extremely exciting" ***Project MED Director***

There is no doubt the project results demonstrate that this experimentation took place, what is more pertinent to this thesis is how effective was the transfer of this experience into IT and learning and teaching strategies within the individual institutions, a topic that will be discussed fully in the next chapter.

The value was clearly impacted by the technical issues that occurred, something which perhaps deflected from the many other areas that the project made progress in, such as the common competency maps between health professions and the engagement of service users in assessment:

> "Whether these tools have an impact is harder to measure because there have been practical issues and problems during the roll out of the mobile technologies and the focus has ended up being on trying to make the thing work rather than just focus on what students and staff are doing with the teaching and learning" ***Deputy Site Lead***.

***Engagement*:** There was no doubt that both student and tutor engagement were badly affected by problems with setting up the devices in the first instance, particularly with the complexities of the mobile application and security software, and latterly were impacted by the growing obsolescence of the devices when compared to the latest smartphones. Apart from setup problems that are discussed below, this was the dominant factor in students not getting engaged with the devices. The funding model for the project forced a one-off procurement of over a thousand devices and did not allow for a staged process where devices could be purchased over a period of time. The devices purchased were 'state of the art" at that time (2008) but were so-called 2G devices which were not able to take advantage of faster network speeds through 3G, which was just starting to become available. This gave rise to slow speed of internet access which became ever more frustrating for students and staff as many of them had their own devices with 3G access speeds. The contrast between the project device and personal devices grew ever sharper during the remainder of the project with the advent of the iPhone and then many of the new generation of smartphones that followed such as Android and newer Blackberry devices, which gained a high-

percentage of the student market due to the free messenger service (Quan-Haase, 2008).

Devices were originally issued to students without any assessment application on them, the idea being that students would familiarise themselves with the device whilst the application was developed, a time-lag which proved much longer than anticipated due to issues in the software development process. Some felt that more guidance should have been given to students (and tutors) on what they could do with the devices whilst waiting for the application to be developed:

> "there was no real guidance as to activity so that they could do little contribution to their learning experience really and so as a result of that a lot of students didn't really bother getting it out of the box after the first time because they just couldn't find a relevance for it. Especially when they've got their own mobile devices and carrying two around without a real direction as to what you're using the project one for" ***Site Lead***.

Once the mobile application was developed and installed, the issues with the installation process and the growing obsolescence of the devices put many students off, although small subsets of the cohorts persisted:

> "there's almost three groups really, there's those that yes I like it and I like using it, I like having one, some that say yes I've got one but I've got a better one elsewhere and it has been superseded as a piece of hardware and others who remained at that stage this is just a load of grief and I've got enough on without it really" ***Tutor***.

The effect was to lose the impact of the power of the mobile assessment, people losing sight of the potential benefits:

> "people get hung up on how rubbish the device is and so that's getting in the way of them evaluating the process of using mobile technology" ***Site Lead***.

Attempts to re-engage students after the devices were recalled, and everything was re-installed to resolve all setup issues, generally failed, even with students whose courses involved dealing with complex technical equipment (such as those working in operating theatres) on a day-day-basis:

> "And the thought was that these students because it was a technical qualification they maybe have a different mindset and they would be interested in picking the devices up and now until the project ends but there wasn't one response from them. Not even an acknowledgement of yes but no thanks. So that was surprising as well. I think there's lots of lessons in there" ***Site Lead***.

But there were students who persisted with the devices and found innovative ways of using them:

> "because there are some good mobile sites out there that some of the students have found so I think that's the ones that have found it found the sites that are good have benefited from that so its actually been more of a communications tool more than anything else" ***Tutor***.

And:

> "They've contacted me with ideas of what they can do and I've got a couple of students who have bought themselves Blue Tooth GPS devices and they've actually put Tom-tom on them and they use them as their GPS for their cars to find their placements" ***Tutor***.

Within areas such as medicine there were some demonstrable benefits too with students beginning to see the potential benefits of the devices not only in terms of in-situ learning but also the ability to record that learning there and then:

> "So that understanding of how these assessment tools can link to an e-portfolio through a mobile device is something that they're beginning to recognise the potential of now and even though I've got reservations about the devices themselves, and the students clearly have, they can see, as I can see, the potential for it in the long term" ***Senior Teaching Fellow***.

Multiple uses of the Device: One of the issues that was frequently mentioned by many interview respondents is broadening the usage of the device by students. If

it just contains the assessment application then this is a once-a-term type activity and thus is not likely to hold the students' attention. This is akin to the text messaging case study discussed in a previous chapter - students aren't incentivised to sign up to use the service if they rarely get a message that assists them and demonstrates value. Several respondents commented on this:

> "If they can send us information through and can talk to our systems like the VLE, which they haven't been able to do, I think they would engage. These are key things to me that if it doesn't do that then it's not going to work, because the idea for me is that students if they're in practice and they meet a situation that they don't know the answer to or that they need some more information on, by using the mobile device they can find out that information quite easily" ***Tutor***.

And also the need to see this as a live and changing environment that encourages engagement:

> "To me to actually encourage students to use these things, there should be something new coming out once a week" ***Deputy Site Lead***.

And many features of the project mobile device were disabled so it didn't offer the range of services that a student would normally use:

> "I've got this one and I've got my personal one, because I can't make any calls on it, so I can't use this instead of my own mobile; and you know the camera's disabled and the video thing is disabled in some areas. So we were running with half a job really" ***Site Lead***.

And:

> "If you can get a number of benefits of using the device -you're getting your institutional email, you're getting text on it, the VLE but you also when you're on placement using it for assessment and learning. This is why I feel giving students devices just to do the project is not enough. I think we've had to do it that way for this particular project, but in the future you could imagine that potentially in the same way that students use their own PCs for a number of different purposes, moving towards a solution whereby they do use their own device. We know there are issues about crossing between students' personal space and their institutional

> space but we don't have any qualms about them using their own laptops" ***Project MED Director***.

This latter point about crossing into personal space is an interesting observation – much research has looked at these issues such as in the case of text messaging (Riordan and Traxler, 2005, Traxler, 2010a) and in areas such as the appropriateness of university teaching utilising social networking sites for teaching purposes (Roblyer et al., 2010). This is an interesting phenomenon in that an institution expects most students will have their own laptop computers and are increasing wireless infrastructure to cope with this and that these laptops will be frequently used to access university systems so is there any sense in adopting a different strategy with mobile devices, especially as they get increasingly difficult to separate from laptop personal computers? However, this is a whole separate area of research and will not be developed further in this thesis.

Finally some of the partner institutions developed learning objects such as training videos that could be accessed from the mobile device and they got better engagement from students as a result of this, again emphasising the benefits of multiple ways to use the device. In addition there was a comment which pointed towards tutor ownership of learning materials:

> "It's about the tutor feeling some level of ownership of what's going on here, if they're pushing out the project tools which they themselves may not have had a direct input into, that's different from if they're pushing out learning material that they had always intended sending to these students and they can now see, oh this is a really useful route to get it out to them while they're in practice" ***Senior Teaching Fellow***.

Business Models for mobile usage: The project experienced a number of issues with the way that airtime and devices were dealt with by the mobile service

provider and also some issues of ownership (IPR) with some of the software that was specifically developed. These issues were:

- Mobile service providers, at the time of this research, didn't appear to have a model for HE use. Examples would be a scheme where the university pays for the data charges and the students pays for the voice calls/ text messages etc. This meant that voice calls had to be disabled on the devices, ensuring that the students would always need to carry two devices with them, a university one and a personal one.
- There was no adequate upgrade path within the airtime contract so the universities were stuck with the same device for over three years which was virtually obsolete well before that period had expired.
- The money to buy the devices was provided by HEFCE who insisted on spending it in one tranche as opposed to incrementally buying devices over the life of the project. This resulted in 900 obsolete devices by the end of the project whereas an incremental purchase would have led to a significant proportion of more up-to-date 3G devices. Funded projects can force procurements, as happened in this case, but it is also a wider problem in the sector which is used to spending money on capital IT equipment (such as desktops), that are fairly certain to have a minimum three-year life. Standard university IT procurement tends towards a bulk discounted buying model as opposed to an incremental purchasing strategy.
- There were some issues in terms of dealing with the IPR of the application developed, part being owned by the project and part being

owned by the software developers. This isn't really a mobile specific issue but does illustrate issues that can occur in outsourced application development.

A number of quotes support the frustration with the airtime contracts that were negotiated:

> "Somebody has said recently, If you get a contract for a mobile device, you get a new device don't you" ***Tutor***.

> "You ask them for free air time, and they say they will, but then what comes through is oh yeah, the devices are £200 each and it's going to cost you £30 a month to get unlimited data" ***Project Manager Mobile***.

> "I don't think any of us quite appreciated that the devices that we were getting in 2005 would be it. Like a mobile phone contract, you have an upgrade and we'd have expected an upgrade but that obviously wasn't built in to the contract and I think that has been a major issue. I would definitely recommend that anybody who is becoming involved in a mobile learning project to make sure that that was built in to the contract" ***Project Director***

The upgrade was one issue but it was also the ability to tune the contracts into a form that was HE friendly, allowing for some division of costs between the university and the student: the university paying for what was necessary for the assessments to be completed and the student meeting costs of calls and additional data usage. The models that mobile operators offered frustrated many of those interviewed:

> "Well I think it's the costing, it's the way that they bill. One of the things that we talked to all of them about right at the beginning was the fact that they needed to develop tariffs that were affordable, tariffs that we could use within HE so it was things like mixing the data usage with some form of pay as you go, so that the student could take responsibility for the calls and the institution picked up the cost of the data. It was maybe about having data tariffs that you could switch on and off, so instead of having a two year contract you'd maybe have a contract that you could switch on for eight weeks while the student was on placement" ***Project Manager Mobile.***

This was contrasted with other technology suppliers to the HE sector who made efforts to produce models for large scale usage in Education:

> ”Microsoft’s licensing is hellish in trying to work out you know but having said that there are affordable models and they do make some effort to be affordable for a large institution like ourselves” ***Faculty IT Manager***

But some senior people thought the sector could do more and utilise bulk-buying power:

> “Now one of the things that I think the university is not doing is talking to Vodafone and Nokia and their like and saying we’ve got 30,000 students here and times that by the cost of acquiring new customers, what kind of contract are you going to give us for airtime for these people and devices” ***Project Director***.

Others felt that the model had to be that of students used their own devices but felt there was still a problem in meeting the data costs – especially if used as part of an assessment process:

> “But still, how many students can afford to be on unlimited data tariffs. I mean we need to do some more research around that…” ***Tutor***.

Given that project MED was aimed at health students, many of whom were funded through the NHS, the five institutions had enquired as to whether they could get a device included in the training contract for the student – something known as the benchmark price for training health students:

> “how do we get sustainable development of the benefits of this particular teaching and learning project. We have a concern about the affordability of a device in the benchmark price because the way in which the unit of resource for each of the programmes is ascertained, it doesn’t factor in at all and can’t be included in current funding provision” ***Deputy VC***.

With further cutbacks in support to health training and reduced student numbers, there seemed no prospect of the NHS paying for devices.

***Technical Issues*:** The project made the decision early-on that it needed an application that would always work in a clinical situation even if no connection to the internet was available. It was a 'store and forward' application in that the assessment once completed, would be uploaded to a central system when an internet connection next became available. This makes for a more complex application, in effect a truly mobile application rather than many 'apps' which are really just links into websites. This 'store and forward' mechanism required the installation of synchronisation software (such as Intellisync) compounding the problems of setting up the device.

There was also a security issue in that hospital trusts, primary care trusts and other health providers were concerned about the possibility of devices being lost or mislaid and data present on the devices being accessible to anyone who found the device. They would not agree to allowing the devices into their working environment unless there was some ability to secure the data and disable the devices if they were lost. This security issue gave an added complexity to the setup of the devices requiring a security application to be installed before the mobile application could be loaded. It proved difficult to get users (students) to both install the security application and the mobile application by themselves and the complexities of this meant that many users gave up with the devices in the first attempts to use them.

Later, the project changed strategies so that the relevant software was pre-installed on them enabling students to leave their initial training with a working device. However the initial problems influenced many students and tutors and led to a low take up of the devices and application. There is an irony in this NHS security concern in that many staff and patients present in these clinical environments, carried with them personal devices with equal if not superior capability and the hospitals and clinics had no apparent jurisdiction over these. It raises the debate as to how other people see the concept of *m-learning* and the view that students may well be using the devices for other activities such as texting. There is a cultural issue here summed up by a comment from one tutor:

> "I think for some reason if a doctor or even medical student is seen with a device on a ward he's perceived as doing something important. If a nurse is seen with a mobile device on a ward, they're perceived as phoning their boyfriend, texting their boyfriend" ***Tutor***.

It's also true that as more and more smartphones appeared on the market, many of these had security capabilities built-in removing the need to install additional software. If the project was restarted today, this security issue at least would be covered by the off-the-shelf operating system loaded onto the phone, possibly in conjunction with remote device management software such as Microsoft's Windows InTune.

An alternative view is that although the NHS appeared to be reluctant to accept the devices into hospitals and clinics, other parts of the NHS, notably those involving home visit to clients, were innovating in this area. Some staff across the five institutions felt that lessons could have been drawn from this:

> "I think the disappointment about the technology is that there were employers at the beginning of the project before we even chose the

> particular device we chose who were already using mobile technologies in the place of work and the disappointing part is I don't think there was enough consultation with employers about what they were using and what their long term plans were; an example of that was there was one of our agency partners, a local authority, had just adopted government policy or strategy very early on in terms of moving to a more electronic system of assessment and recording and had issued huge sections of their staff and children services, adult services, health care services fairly rudimentary devices in terms of what they do" ***Deputy Site Lead.***

***Links to IT Strategy and other links or "points of passage"*:** Perhaps the most interesting aspect of this project was the way in which it was supported by IT Services in all the five institutions but the strength of that involvement varied, depending on the structure of IT provision or the individuals involved. Each university had a representative on the IT group who was essentially an IT Services employee. However the way that IT Services was structured varied across the institutions as did the ability of the local IT representative to influence the overall IT choices of the institution. For example University A had a very complex structure whereby the faculties had their own servers and where the central IT service provided infrastructure (connectivity and some services such as email) and learning technologies (i.e. the VLE). The effect of this was to allow a lot of local freedom and as long as the faculty could finance an initiative, it could be deployed without support from the central IT department. This was an exception in that most of the other universities had a setup which was similar to that in project SMS: local faculty IT officers but with the IT environment clearly controlled from a central department that managed all the equipment and servers.

It was clear that IT Services were involved in the project and the project was open to being influenced by central IT Strategy. Over the course of the project, a number of workshops were held where senior IT personnel from the five

institutions attended and clearly participated. The effectiveness of these links in terms of using the experience from the project and encapsulating that in future thinking re mobile and teaching and learning was questionable. In other words, did points of passage exist between the project as initiated within each institution and those institutions' IT and Learning and Teaching strategies? These links are explored in-depth together with supporting evidence in the next chapter.

7.4 Chapter Summary

This chapter has developed the background to this project and identified a number of generic issues that relate to the *m-learning* aspects of the project. These issues reinforce some earlier findings from the initial field study with ten institutions (Chapter 4) and the text messaging pilot study (Chapter 6). They represent the *m-learning*-specific aspects of this research and will be reflected on further with respect to existing literature in the conclusion to the thesis. However, it is worth summarising the generic findings from projects SMS and MED in the following table (Table 8):

Issue	Project SMS	Project MED
Demonstrating Value	Where it saves effort for students and staff, then value is not disputed.	The biggest value is probably in the situated learning- being able to access information at the patients' bedside
Engagement	Students and staff appear to welcome text messaging although usage is sporadic	Both students and staff like the idea but impact suppressed by device limitations and problems
Links between project and central IT Strategy	Links exist but lack of strategy led to proliferation of solutions.	IT aware and broadly supportive of project in all five institutions but different approaches to embedding led to variation in effectiveness of points of passage (see next chapter)
Communication policy and strategy	Tutors not sure of when text messaging should be used and who is responsible	Not really a focus of project MED
Multiple uses of Device	Using students' own device rather than constrained institution provided one. Hence issue is not a focus.	A major issue which links back to engagement. Students and staff want devices which can be used to access all learning resources and systems.
Technical problems	No major technical issue although integration with institutional VLE and student record systems is an issue which was not resolved centrally – thus encouraging multiple systems to be developed.	Significant problems which impacted on other areas such as demonstrating value and engagement.
Business Models for Mobile Usage in Education	Plenty of competition and models for bulk text messaging.	No satisfactory solution provided by mobile operators either for university supplied device or model that uses student owned devices.

Table 8 – Generic *m-learning* issues

Analysis of evidence from project SMS and project MED demonstrates a number of generic issues that relate to introduction of new *m-learning* technologies. As the focus of this research is primarily embedding the next part of the thesis will use project MED to examine that in more detail. The pilot project SMS has already demonstrated that links between these projects and central IT strategy are a potential problem leading to proliferation of local solutions. The next chapter will look at each of the five institutions from project MED in detail and look at the embedding process from an Actor-Network Theory Perspective.

8. Project MED: An analysis of the actor-network in each institution

The previous chapter assessed the generic problems the project experienced, providing analysis and commentary at a project rather than an institution level. One might expect an identical trajectory for the project in each institution through the project, as each had experienced the same problems with the devices that could lead to the swift conclusion that the projects had failed. Each institution was also facing the problems of funding in a new market with the shift from core funding through HEFCE to student fee-based funding so opportunities to continue these *m-learning* projects were limited. Nevertheless there are marked differences in the trajectory of the projects in the institutions and it is interesting to look at reasons why some of the institutions were able to use the project as a springboard for more *m-learning* activity, whereas others have apparently not continued. The next sections will look at each individual institution and how the project and actor-network trajectories developed.

8.1 University A

University A was the lead partner. It not only had over 250 students and at least 15 tutors active in the project, but also project managed the whole programme on behalf of the five universities and handled the procurement of devices and services. They also facilitated the various partnership groups such as IT and Tools and provided the overall Project Director. The focus of this section will be on embedding and the relationship between the project and central IT services. In

terms of issues such as engagement of staff and students, then the experiences in University A echoed the generic issues described in the previous chapter.

The IT structure within the institution was distributed in that it had elements of being centralised - the network, the VLE, email etc., were provided centrally, but faculties had differing levels of autonomy in how they ran their own IT. Faculty IT managers reported into the Deans or Heads of Department although they also had connections with central IT services. Some faculties ran their own servers whereas others bought in server support from a central IT department. The project was thus somewhat remote from any central IT strategy as the departments involved had a great deal of autonomy in their decision making, provided that they could finance the work themselves

8.1.1 University A mobile strategy

It is fair to say, prior to the project starting, there was no real mobile strategy in evidence apart from the use of BlackBerry devices by staff in senior and executive roles, and it is unclear how far that situation had moved during the project lifetime. The project clearly felt that it needed to break new ground and its support from central IT services was only in helping with issues such as authentication of devices. Expertise on *m-learning* came primarily from the sub-contractors who developed the mobile application and the rest was developed by trial and error over the project where the team became skilled in finding solutions to a whole range of technical and administrative issues. The priorities of the institution were supporting student laptops and introducing a new VLE and quite reasonably *m-learning* was seen as a niche. Quotes that sum up this position are:

> "IT invested a lot of money in the VLE and I think it sees that as the way it's going to drive through what it's terming blended learning. I think it views mobile learning as a specialist" ***Faculty Learning Technologies Manager***.
>
> "Well I think it's borne out of the fact that it's only recently IT have managed to get control of the laptops - and it's sort of debatable whether they have full control of that now" ***Faculty IT Manager***.
>
> "Certainly here and it's not necessarily the case at all of the partners, but certainly here there's a certain wariness and reluctance to go into the mobile learning world or just the world of mobile devices at all" ***Faculty IT support***

And one comment would appear to encapsulate the status of *m-learning* within the whole sector, at least at the time the field research was carried out, comparing *m-learning* to the introduction of the PC:

> "Yes this might be naive but it feels to me like mobile technology in terms of business or enterprise adaptation is where PCs were twenty years ago where people were thinking, oh no PCs they are toys, they're personal things. PCs were around but, it was mostly terminals and mainframe-type computing people saying PCs? They're never going to be adopted in business: and then PCs crept in and corporate IT departments spent the next ten years trying to bring them under control " ***Faculty IT Manager***.

Lack of the ability to integrate with other systems was also cited as a major disappointment within the project. It is clear from all five institutions that just having an assessment tool on a mobile will not engage the students fully as it is a once-a-term experience: systems are required which create multiple modes of usage and thus regular interaction. The pilot study project SMS also bears this out as students may never appreciate these services if they only get one message per term; there needs to be something else. The absence of the ability to access the VLE from the mobile devices was a big disappointment to many tutors and local IT staff:

> "The VLE which was bought by the university… they've only launched it has been going a year now but it really doesn't have a mobile interface shall we put it like that and I think you know we presented to the blended learning futures group and about the project and I think they acknowledge in fact it was their suggestions that they missed a trick by not including that more strongly in the ITT document" ***Deputy Site Lead***

And:

> "I get the distinct impression IT see mobile as a bit of a pain and certainly recently we've had a new VLE put up and there's no mobile-enabled site there" ***Site Lead***

And within specific health disciplines there were packages and databases that would have been very useful to students:

> "One of the things we were hoping to use was an electronic competency logbook which is quite a big beast and has its own web site housed in the university and we were hoping to be able to access that but the formats weren't right" ***Tutor***.

And perhaps the gap between central IT and the project is summed up by this comment:

> "So sometimes we get simple issues where IT say we are going to migrate your folders tonight and I'm thinking well does it affect my mobile device or not. So I haven't a clue, they can't tell me, so let's wait and see what happens" ***Deputy Site Lead***

8.1.2 Points of passage

Looking at this in Actor-Network terms, we have a clear local network that can exist more or less independently of the global network. It needs occasional support from the institution in areas such as procurement but in terms of resources and expertise is largely independent. Scepticism is a theme expressed by many respondents, doubting that the university was really taking on board the experience of the project. It would be unfair to say that central IT services pro-

actively ignored the project as the researcher observed their attendance at two special meetings organised by the project, but it would be fair to say that they saw the project as extremely peripheral, perhaps given other higher priorities such as increasing Wi-Fi access and introducing a new VLE. However, there appeared to be no mechanism to capture the experiences of the project in a way that would inform a longer-term mobile strategy, no visible capacity-building link that captures the local network experience into the global network IT strategy. Examples that support this are:

> "there are people who are..the IT people..who are IT specialists and then the academics who are academics and there seems to be very few people who can see the way forward and join the things together so that they are not separate and that for universities they are very much linked and I don't see somebody with the vision who can prepare the institution for what mobile learning may bring" ***Project MED Director***.

Many of those interviewed doubted the impact of the project on the institution:

> "Yes I think they'll probably deal with that by just avoiding implementing using mobile devices" ***Tutor***.

And others thought the engagement between the project and the central strategy was coming too late:

> "from a strategic point of view, probably again a bit late in the day but over this last six months or so we've had some engagement" ***Deputy Site Lead***.

And there was evidence that long-term strategy appeared to neglect the experience of the project:

> "Well we were quite sad when they came up with some IT strategy and when we read it our Project did not figure into it at all and that, I'm not saying that they should do what we've done because we've learnt a lot; but wouldn't you have thought they've got a very big project which is gaining experience?" ***Deputy Site Lead***

There was a potential link from local project to global institution strategy as at least one project member was involved in something which included *m-learning* in its' remit:

> "I am a member of something called the blended learning futures group which is about advising and developing blended learning across the university and one of its remits is very much around developing mobile learning. So the university is acutely aware that it's there but they think it's probably premature to start" Faculty ***IT Manager***.

And another view echoed this:

> "I think it's willing to recognise the fact that we've got a centre of excellence here and you know they are willing to talk about it; but I don't think there's a drive to widely adopt mobile technology across the university. Now I mean that may be because they're not getting the feedback from the other faculties which see mobile technology as being important and they may just say well actually this is a niche interest" ***Faculty Learning Technologies Manager***

The apparent lack of capacity-building by the institution in failing to capture the local project experience, fostered further concerns. Foresight was another interesting theme in ANT terms, the need for people who can recognize what is coming and prepare the institution, and act as points of passage into future strategy. Some respondents including the Project Director felt that change in learning styles was coming as younger people embraced technology in their learning activities:

> "I don't see the visionaries who can think, wow this is going to change how kids learn and kids coming in are learning in different ways and although people talk about that, there isn't any explicit thing which looks at what kids are doing. Kids have been exposed to much more in the way of IT intimately linked to their learning before they come in to us. Now not all of them are the same and we need to make sure that everybody gets up to the same level but we need to anticipate what these kids expect when they come in" ***Project MED Director***.

And:

> "well we are still just talking about it and umming and erring about it so give it what seven or eight years these kids are going to be here" ***Deputy Site Lead***.

Resistance to the message coming out of the project was also evident:

> "And, and so we're bound to keep going back to them banging on about the fact that we're not asking you to adopt this project: But what we're saying is talk to us let us input our experience because we have the most experience of, certainly of mobile learning. And I mean I think it's improved a bit but at one stage we were more influential outside than we were inside the institution" ***Deputy Site Lead***.

And when interviewed, representatives from central services conveyed the fact they felt the project was not mainstream:

> "So I've had discussions about the project purely in the context of okay we're looking at some sort of handheld device and I know you've got a programme out there, understand what that is and see if there are any synergies with that, so its really peripheral to us. So I just wanted to make that clear." ***IT User Services Manage***r

8.1.3 Embedding

The evidence would suggest that embedding at an institutional level was weakened perhaps because there wasn't a clear and strong point of passage between the project and the overall institution global network. In effect the faculty had the IT staff and resources (provided through the project) to continue without much support from any central function. Even though the central function is at risk of losing some of the project's work within the longer–term strategy, the local network could maintain the project work as long as it can finance it. And indeed this is what transpired as one part of the project (Medicine) was able to get a grant (from healthcare funding sources) to equip medical students with iPhones and continue the online assessment software for those students. In addition a number of other resources (apps) were to be placed

on the iPhone to give the students access to electronic versions of drug and anatomical information. Having learnt the lessons from having to support out-of-date devices and perhaps more importantly, providing students with multiple reasons to use the device, they have embarked on a process where all medical students will have the devices. Whether this will be embedded, or whether funding will always be available to buy the students devices remains to be seen. But despite this effort, the link to the overall institution strategy is still somewhat tenuous –the iPhone work can progress really without support from central IT services.

It is interesting to see what the views were on embedding. The self-contained nature of the School of Medicine with its strong IT team was in contrast to other subject areas such as Nursing, which relied more on central IT services for resources and lacked the funding opportunities associated with training doctors. The issue of cost loomed large in the interviews with most reflecting on the squeezing of higher education funding:

> "I would be surprised if we were able to embed in most areas. Because I think there are going to be challenges around them financing IT development and support; and I think it's going to be difficult to persuade people to spend money... … who may think well actually we're not that keen on mobile learning anyway." ***Site Lead***.

It was not just issues of cost that prevailed but also concerns about *m-learning* not being recognised as something strategic. The evidence on points of passage points to a lack of linkage between overall IT strategy and the project. The intention was to impact the strategy in a longer-term way:

> "I think it goes back to that the project is giving some of the questions that they now need to go and answer and of course what we've done is we've now hit a very bad financial situation so it's about seeing it as

> strategic from day one. In some partners, the project is seen as part of their curriculum development, part of their e-learning so that's embedding. In my view it's about giving partners a launch pad to take some of those decisions and to help them pick and choose" ***Deputy Site Lead***.

However there was an output from the project that did influence strategy in University A. The CETL had some money which was used to create a learning space within the faculty library where students could use their own laptops/devices and this clearly had a big impact on central strategy, spawning a strategic look at how learning spaces could be delivered as opposed to creating more and more computer labs with fixed terminals:

> "that was a small bit of money that went in to a small bit of refurbishment here at the university which has had massive implications. It's had an effect which was all about Wi-Fi, group learning areas, which was actually something that developed in to quite a work-stream because it has fed the university strategy on space to learn which is their document on what they're going to do over the next ten years or so with PCs on desks and clusters" ***Faculty Learning Technologies Manager***.

But despite that there was an overwhelming feeling of concern that the lessons of the project could be potentially lost:

> "Early on in the project, agreements may have been put in place with someone in central IT services and that person then moves on and so actually you find that a year down the line you are suddenly having to explain it all again to somebody who's unaware of the situation" ***Project Manager Mobile***.

And:

> "So we hope that there is some dissemination out of Health into the institution. I do worry that in 10 years' time people will look back and think, oh gosh you know we were doing things like that beforehand and people haven't taken notice of it" ***Deputy Site Lead***.

It was acknowledged that Medicine would be able to keep the project going independent of central IT services due to their sources of funding and large IT team.

> "I suppose because of the different way that medicine is funded they have a big learning technology team or so, so they can develop mobile learning as they go along and so that is the difference they have" ***Tutor***.

But others thought this might lead to proliferation of solutions:

> "And I think the danger is that you will end up with people doing things with mobile technology in an uncontrolled, maybe slightly inefficient way and if you had some sort of central policies in place and services in place you could actually make better implementations. But, that's the way it is" ***Faculty IT Manager***.

This really echoes the findings from the project SMS pilot study on text messaging in that strong local networks with the ability to develop their own solutions can proliferate implementations that solve similar problems in the absence of a strong central strategy.

8.1.4 ANT Analysis – University A

Before examining the project trajectory using the Law and Callon diagram, it is worth summarising the project history within University A to demonstrate the demarcation between stages of the project.

Project History

When the project was bid for, it had senior backing within the institution given its profile as a CETL and the size of the funding on offer. Once the work started in earnest it quickly became clear that there was little or no experience to call on within Central IT services and the project had to seek help from external

partners. A number of partners were identified and some trials took place with mobile devices within University A and also within the other four institutions involved in the project. Taking into account the feedback from the trials a device was selected, final development partners were chosen and the project used the central service to procure the devices and arrange the contracts with the vendors. Students were then issued with devices and the application was installed when it became available (application development lagged behind issuing of devices). Students experienced numerous installation problems with the devices which resulted in a low take-up of the application. During that time there was little linkage between the project and central IT services. The project then took the decision to recall the devices and pre-install the software before re-issuing them to students. The subsequent use of the devices was not widespread because tutors and students were partially influenced by their prior experience and the slowness of the devices compared unfavourably with the newer smartphones that many students has begun to acquire. During this time some members of the project participated in a centrally driven project looking at learning spaces and although mobile was within its remit, learning spaces focused upon replacing traditional IT labs with space and infrastructure that supports students' own laptops. Finally the end of the project arrived and most parts of the project decided not to continue with the mobile assessment which was partly down to experience but also due to lack of funding. However the school of medicine chose to continue with the project and migrated it to a new iPhone-based platform. It was able to do this independently from central IT services. Thus the local network had the momentum to maintain the project without global network support and it's unclear whether the experience of the project had any influence on central IT

strategy although with the continuation in Medicine, the opportunity for the global network to re-engage remains.

Law/Callon trajectory University A

The project trajectory is represented by the following diagram (Figure 11):

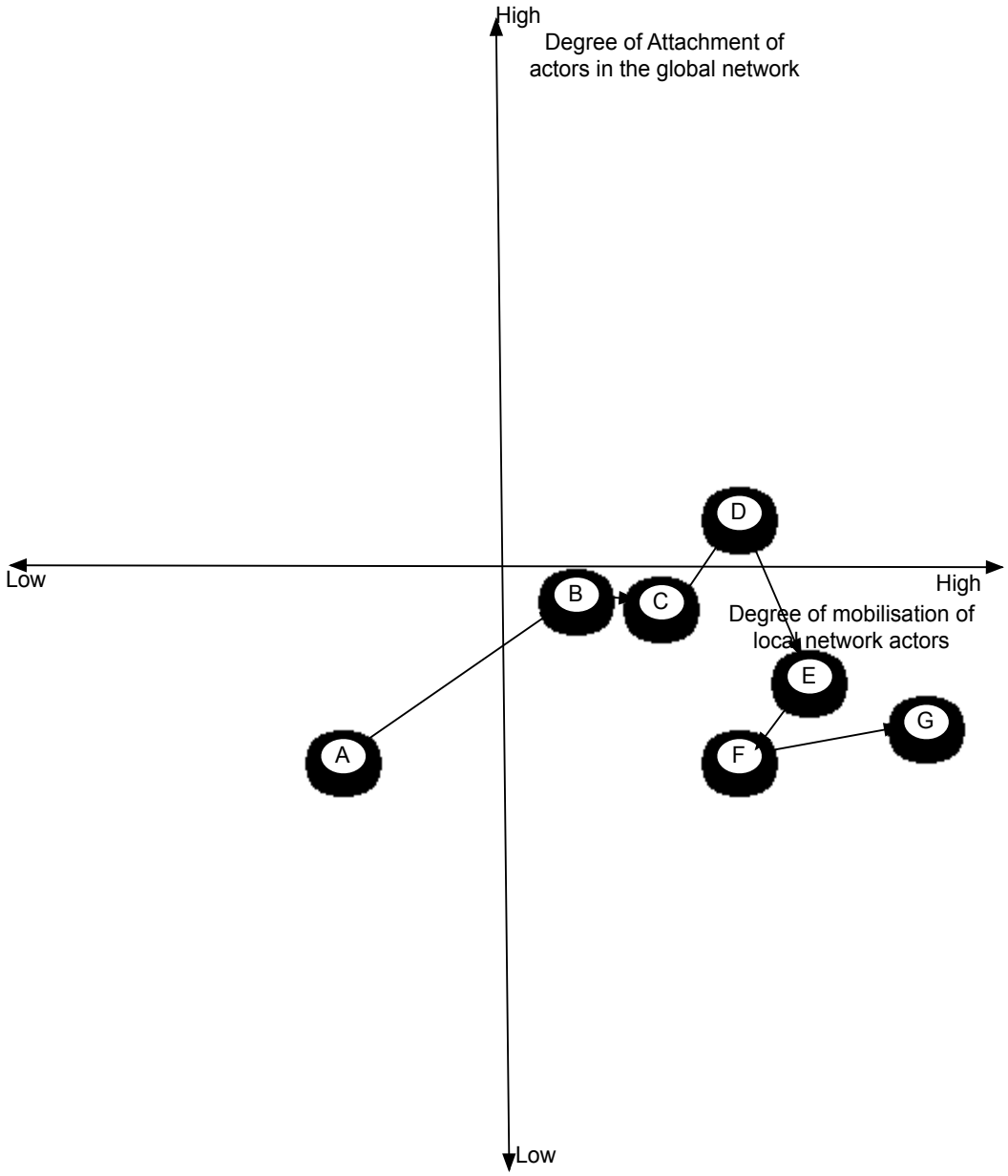

Figure 11 - Project Trajectory University A

	Event/decision	Local consequences	Global consequences
A	Initial idea	Resources to undertake the project.	High-profile project - opportunity to learn more about *m-learning*
B	Pilot	Try out devices with groups of students to gain initial feedback.	Not involved in this phase
C	Technology Choice	Seeking guidance on best practice.	Unable to offer advice centrally - local network needs to develop strategy together with other university partners
D	Procurement	Project needs to use government procurement guidelines so needs to use procurement help from central services	Help with procurement process but no help on technology choice
E	Implementation	Deployed but considerable problems due to complexity of device setup and slowness of devices	Watching from a distance with occasional reports through meetings initiated through local network (project).
F	Final Project Service	Setup problems resolved but students frustrated by slowness of devices prevents widespread deployment. Many cohorts using paper systems.	Claim to be waiting on project results but no evidence of strong link between project and IT strategy.
G	Embedding	On-going implementation of system using new technology (iPhone) with extra facilities for medical students. No embedding in other disciplines.	Local network (medicine) can implement without central services support so again see as a niche with no clear links to longer term strategy.

Table 9 – Project Stages University A

At point A, the project commenced with little involvement from the global network. At point B, technology choice, the local network asked the global network in the form of IT Services but centrally there was little knowledge to help. Pilots took place in all five institutions (point C) and choices over

technology were made. At point D (procurement), the global network offered considerable help in procuring devices and negotiating agreements with suppliers. Implementation (E) and Final Project service (F) occurred as the local network tried to get students to engage with the devices, Some interaction with the global network occurred as presentations were made to IT Services representatives but no formal mechanism to share the project results was established. Embedding did not occur in most subjects apart from Medicine due to funding shortages and the poor student experience with the system. Embedding (at least in the area of Medicine) occurred because the mobilisation and independent capability of the local network was strong and did not require much if any support from the global network. The degree of attachment of global network remained weak reflecting the fact that links between the project and future strategy did not appear strong and the concept of *m-learning* is very much seen as a niche rather than a core service.

In Summary, University A is the one institution which was able to continue the *m-learning* project after the CETL programme ended but capacity-building links into the global network appear to be weak, with a clear risk that future strategy might not be well informed by the project. As usage has continued in the School of Medicine, then the future possibility of knowledge transfer to the global network remains so University A may still achieve that transfer in the future.

8.2 University B

This was a large post-1992 university that taught a wide variety of health subjects such as physiotherapy and dietetics. The IT structure of the institution was much less distributed than University A with central IT management plus faculty IT teams which reported into the central operation. There was no real separation of functions so central IT Services provide the network, the servers, email and the VLE. Most of the IT provision was centrally purchased but if faculties needed additional packages or facilities they had to fund those themselves. The university had the traditional IT labs with desktop PCs but was moving more towards a laptop supporting environment with a large pool of laptops available for loan and significant investment in wireless infrastructure.

8.2.1 University B mobile strategy

As in all the institutions that were researched, this institution also lacked a mobile strategy when the project started; there was no demand to have one at this time. However the central IT services did look upon the project as a capacity-building experience that would inform the strategy and had a number of mechanisms which supported that approach, such as an information policy committee which had membership from each faculty. Project MED also funded the concept of Research Fellows whose remit was to input their experience into the institution and help influence future teaching and learning strategies. The university had a technology enhanced learning (TEL) team that was led by a high-profile individual who was also working on the project so that helped cement the links between the project and the university strategy:

> "I'm having an information strategy group as well which is the cross university group that drives forward the implementation and development of our information strategy so you know faculties are represented on there, TEL is represented on there, service areas are represented on there and so it's an across university group and we look at the strategy, we look at updates for that strategy, we look at implementation" ***IT and Libraries Director***.

From the perspective of the leader of the TEL team:

> "I have this role in the TEL team that gives me opportunities for disseminating the project in the university because I'm a member of a number of committees, I'm involved in assisting with helping to have input into policies, such as the information policy" ***Teaching Fellow, Health***.

Discussions took place to see how the project could inform the strategy:

> "And we have actually had the first meeting of a strategy group to begin to think about how we're going to move forward with mobile technology and certainly the outputs of the project are included in that group. Obviously the policy for the university is wider than that but certainly this is considered to be a project that can inform that process" ***Teaching Fellow, Health.***

It is difficult to judge how effective this process will be in the longer-term since the business case for developing an assessment based project like this is clearly subject specific and not necessarily something that will be delivered to all students. Hence there is some danger that although IT services are keeping a close watch on the project, it really is just that and not a conscious plan to develop a new strategy as the IT Director acknowledged:

> "I attend meetings about two or three times a year so I'm kept up to date on what is happening and if there's any impact on what we're doing at the moment there isn't, it has all been very high discovery, here's what we're trying, I've found it very useful but I'd say there's been very little impact on our delivery at this time it has been informational mainly" ***IT Director***.

Apart from the links to IT, there was also concern that there should be a feed in to other institution strategies around teaching and learning and just linking into IT was not enough:

> "but everything to my view should emanate from the assessment learning and teaching strategy of the institution. So unless you've got mobile technology in there you are not going to progress" ***Teaching Fellow, Health.***

In other words a holistic approach was important, it's not just about being able to procure and support the technology:

> "That is very much the approach we are trying to take and in fact we've got quite an ethos currently going on about having a holistic integrated approach to things. So you think about embedding of the project and its output and it has to be put in to the context of that ethos at the University and how we're moving forward with things" ***Site Lead***.

8.2.2 Points of Passage

A strong feature of this university's approach was the concept of Teacher Fellows who were networked together in a number of ways which informed the university's teaching and learning strategy and IT strategy. The project had allowed the university to fund two Teacher Fellows over the period of the project: one to focus on *m-learning* and the other to focus more on the assessment methodology. The Project Lead for the university saw this as a major strength of having the CETL funding:

> "I was able to appoint X who subsequently has been directing our university technology enhanced learning team so we're in a very beneficial strategic serendipity position of having X who has both been able to lead on all of the mobile elements of the project and also be extremely well placed within the institution by (A) directing our learning technology unit and (B) being the lead over the last 18 months for the whole university technology enhanced learning team" ***Site Lead.***

A very clear point of passage between the project and central IT strategy was thus built into the local and global networks at the project initiation. And all the

parties interviewed acknowledged the strength of the Teacher Fellow networks that had been developed:

> "We have a well-established Teacher Fellow network so they meet with one another so they are really champions of change in terms of innovation in assessment learning and teaching so again we've kept the Teacher Fellows very much up to speed" ***Site Lead***.

Furthermore, from an IT strategy perspective, it was widely acknowledged that the Teacher Fellow network was an important feed into the overall strategy:

> "Well X is a member of the technology enhanced learning team in the university and, and, and you know that team is very innovative team, looking at the pedagogy, looking at developments in technology and how it can contribute to teaching and learning. I think they're a very important group in looking at how we implement and develop the strategy going forward, information strategy going forward, then they're one of our main consultative groups so we work very closely with them" ***IT and Libraries Director***.

The IT and Libraries director also cited evidence that the learning and teaching fellow for mobile had been seen as an important link for IT to follow:

> "X was involved very early on with the project and in fact we bid as the university to do a smaller sub-project within that and they spoke to me and discussed it with me and I said I would like to get our library team and IT team involved straight away, get some people involved with that" ***IT and Libraries Director***

And central IT also put forward people to link with the project:

> "It seemed appropriate to keep someone who from the university point of view, central services, to understand what the Project was, where it's going, and making sure that it doesn't get carried away and try and ask us to implement services that just aren't going to be feasible" ***IT Director***.

So there appeared to be a strong point of passage between the university and the project, far firmer than with University A for example. The project was seen as feeding directly into the Technology Enhanced Learning team which in turn was a key input on the Central IT Strategy Committee. The particular individual (X)

mentioned in the above quotes was well known across the university, so the point of passage was not only the links between the Teacher Fellows and university strategy but also the presence of a powerful and enthusiastic individual who reinforced that point of passage at every opportunity. University B appeared to put a capacity-building strategy intro place from the outset but as discussed below, other issues can still overtake such a plan.

8.2.3 Embedding

Given the strong links between the project, IT Services, the IT strategy and learning and teaching strategy, one might expect that embedding would have occurred. However, most of those on the project saw that the application being developed was fulfilling a niche within health and was not expected to spread to other subjects. Also a number of participants saw the project as informing longer-term strategy and thinking. It was also apparent that the project strategy of supplying students with smartphones was never seen as a viable option by the university who couldn't envisage paying for the phones or the airtime. In terms of the devices and application itself, the project didn't feel it was at a point where it could ask students to use their own smartphones and load the application on there:

> "No I don't think we'll be doing that and I'm not confident that we will be saying to students bring your own device - we won't be in that position. We might be in that position in the future" ***IT Director***.

The Site Lead also felt that supplying devices was not viable not only because of cost but the technology quickly became out-dated:

> "The area where I'm less confident about embedding is the mobile devices themselves. Partly well principally I suppose because of cost, plus the pace of change" ***Site Lead***.

Another area of discussion around embedding emerging from interviews in university B is a notion of breadth and levels of embedding. Some view it as institution-wide whereas others might regard embedding as successful continuation in one area such as health:

> "The only way in which you know this is going to be embedded is to be embedded within the context of the emerging decisions and framework for the mobile learning of the university as a whole: it's never going to work if its simply a Faculty of Health trying to do this never mind simply a set of courses within the Faculty of Health" ***Site Lead***.

This clearly comes from the angle that impacting the longer-term strategy that is key, not embedding the specific application within one small part of the institution. But others thought it was perfectly reasonable to regard embedding as something that happened where there was a real need:

> "I think health probably will, will want to use some of that technology more, particularly because of students being on placement in hospitals and clinics. I guess the only other area that is like that is probably teaching Teacher Ed. that has more of that type of engagement with practice throughout the duration of the year of a course" ***IT and Libraries Director***.

And:

> "for certain courses fine and I think that will be a local choice I think. At the moment I don't think it will be an institution choice" ***Teaching Fellow, Health***.

This discussion on the meaning of embedding needs to be contrasted with the view of embedding expressed in the literature review and methodology sections in this thesis. The research has taken the view that embedding will mean looking for evidence that *m-learning* is being considered in the institution IT strategy, not that a particular application has been adopted widely. This discussion from staff at University B refers to whether embedding is regarded as a local matter (i.e.

within a faculty or subject) or whether it has to be at the institutional level. The view taken in this thesis is very much at the institutional level, i.e. the institutional IT strategy not the local IT strategy.

The complexity of the project's software also meant that IT Services staff didn't feel it was practical to scale up the application:

> "I think that where it is now. I don't think it's at an enterprise level. I don't think that it could be implemented for 20,000 students it's just not got, the integration as it's too standalone" ***Faculty IT Officer***.

This next comment also stresses the role of champions and Teaching Fellows and also expects longer term success as the technology improves:

> "I think like most of these things you end up with a few champions that help push it forward and grow it and I think you know as the maturity of the platforms and sensible solutions to contracts and things like that come forward that will help to grow it and embed it. But I think that is definitely going to be a challenge and its got to be done in the context of the wider strategy of how mobile devices are being used in the institution. I don't think you know you can embed it in isolation" ***Teaching Fellow, Health***.

Despite these statements that look at whether embedding is a local or a global phenomenon, there was plenty of agreement and evidence that IT strategy was being impacted by the project and that lessons were being captured even if no immediate implementation arose. The site lead, a deputy dean, met regularly with IT Services:

> "So we've been regularly keeping them informed not simply just by winging them an email but actually meeting with them, talking to them sharing thinking about whether in the future it will be students bringing in their own devices in. We've engaged them in that debate" ***Site Lead***.

And the director of IT Services was very firmly committed to learning from the project, seeing it as a pilot that would inform the future:

> "What I've been involved with is how we develop the transferable points from that project, form our strategies going forward as a university in terms of mobile learning" ***IT Director***.

Although others felt that the strategy wasn't yet mature enough to push it out:

> "And I think that mobile learning might be something that could embed but I just don't think there's a good enough strategy at the moment for it to be used properly " ***Faculty IT Officer***.

But there was an overall feeling that the project had had the right influence on longer-term strategy and it was a matter of time before *m-learning* became more widespread in the institution. Several likened the introduction to that of VLEs:

> "I was certainly involved in the early push out of VLEs and it was very similar to this. There would be lots of people that say that's never going to work, why are you doing that, look at all the problems and issues, it's never going to work, its never going to add any benefit. As these things mature, and become a little bit more embedded that's when you see the real benefits. I think when you ask students whether they find it beneficial, most would agree that the VLE is but that wasn't how it was in the beginning" ***Teaching Fellow, Health***.

Although *m-learning* hasn't been embedded after the project finishes, there does seem to be evidence that the project experience is seen as important for longer-term strategy. That these links can be effective is supported by the fact that the institution did embark on a project to provide E-portfolio capability across the whole university that was another aspect of the project and was inspired by the use of E-portfolios within the mobile assessment tool. It is also worth noting that this institution went through significant change towards the end of the project as a funding crisis led to major changes within the university executive, including a new VC. In fact this does not seem to have had much impact on this project, the decision not to embed the project application as is was already taken. And furthermore all of the senior IT people, senior managers and Teacher Fellows

involved in the project remained in post after all the high-level changes, so organisational memory was preserved.

8.2.4 ANT Analysis - University B

Project History

When the project was bid for, it had senior backing within the institution and also a firm steer from Senior IT Management to use the project as a vehicle to inform IT Strategy. Links between the project and IT were put in place through senior contact between the Faculty of Health and IT Directorate, a Technology Enhanced Learning team, Teacher Fellows and through the partners IT group. Once the work started in earnest, the global network was kept informed of what was happening but the technology choice was performed mainly with the partners and external providers such as network operators and software developers. Before final technology choice, trials took place with mobile devices within University B and also within the other four institutions involved in the project – IT services was kept informed of the results of the trials. Taking into account the feedback from the trials a device was selected, final development partners were chosen overall, and procurement was handled by the lead partner, University A. Students were issued with devices and the application was installed when it became available (application development lagged the issuing of devices). Students experienced lots of installation problems with the devices which resulted in a low take-up of the application. During this time there was considerable linkage between the project and central IT services who were regularly informed of the issues and problems. The project took the decision to recall the devices and pre-install the software before re-issuing them to students.

The subsequent use of the devices was not widespread because tutors and students were partially influenced by their prior experience, and the slowness of the devices compared unfavourably with the newer smartphones which many students began to acquire. Finally, the end of the project arrived and the university decided not to continue with the mobile assessment application as is. This was partly down to experience but also due to lack of funding and the feeling that any solution must be based on using students' own devices. However the Technology Enhanced Learning team fed the results of the project into the institution IT strategy and discussions started about how to encapsulate *m-learning* in that strategy in the future. Although embedding of *m-learning* has not occurred, there appeared to be embedding of ideas from the project and lessons learned so future strategy has the potential to be informed by the project knowledge base.

Law and Callon trajectory – University B

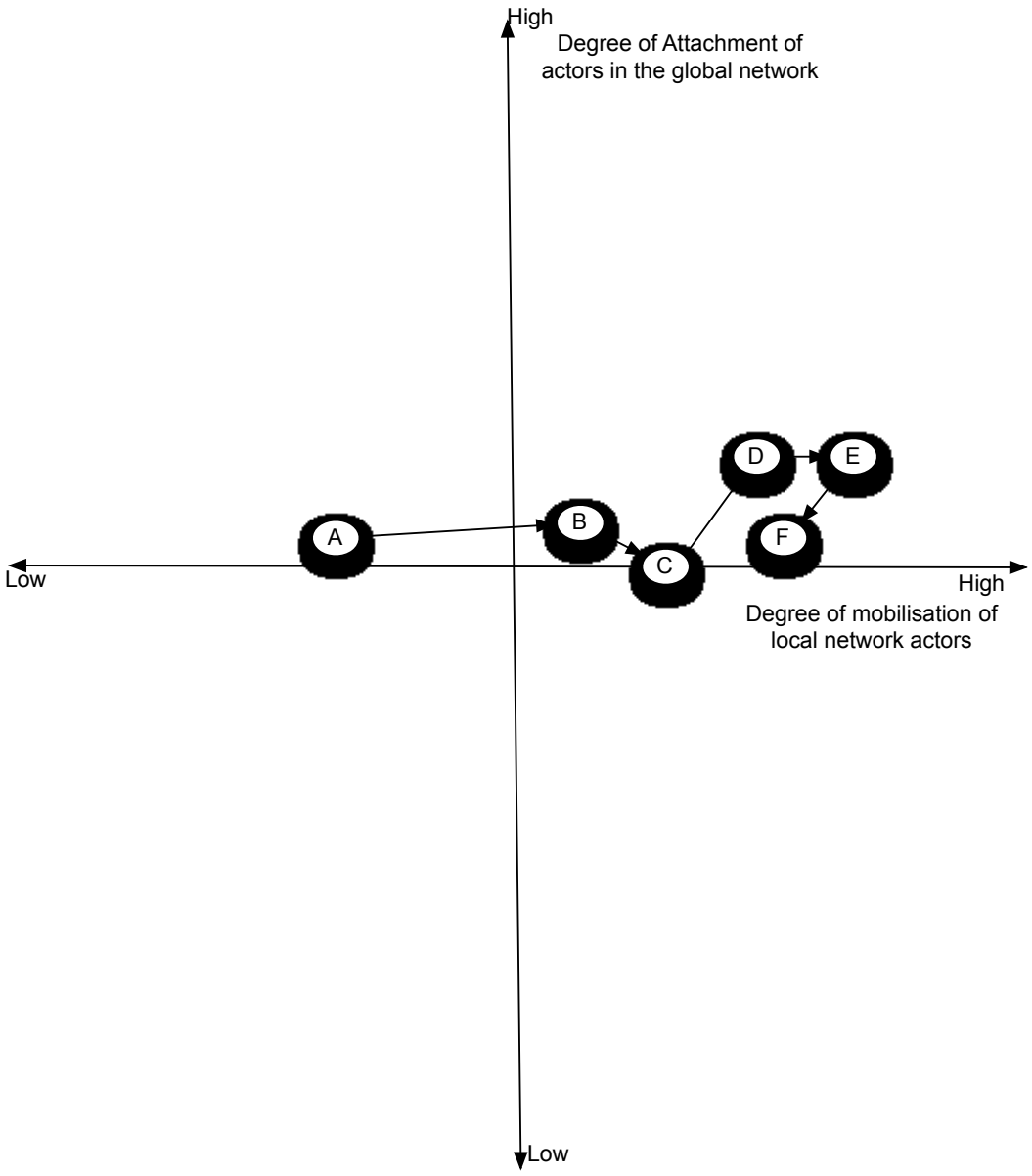

Figure 12 – Law and Callon trajectory University B

	Event/decision	Local consequences	Global consequences
A	Initial idea	Resources to undertake the project.	High-profile project - opportunity to learn more about *m-learning*. Input to IT Strategy actively sought and encouraged.
B	Pilot	Try out devices with groups of students to gain initial feedback.	Having some IT staff involved in looking at this. Also library staff encouraged to take a look. Teacher Fellow network kept informed.
C	Technology Choice	Seeking guidance on best practice. Both within the university and across other partners	Keeping a close watch on developments and central IT Services involved in overall partner IT group.
D	Implementation	Deployed but considerable problems due to complexity of device setup and slowness of devices	Regular reports through, technology enhanced learning team, teacher fellow network and periodic reports into IT Strategy.
E	Final Project Service	Setup problems resolved but students frustrated by slowness of devices prevent widespread deployment. Many cohorts using paper systems.	Continuing Reports through TEL and Teacher fellow networks. Start to discuss Embedding.
F	Embedding	Can't continue once funding runs out as devices now too slow and no budget to replace. Focus on embedding concepts from the project rather than embedding the project solution.	Discussions with TEL team & Teacher Fellow network on project results. Project seen as input to longer-term mobile strategy within institution. Short-term priority seen as E-portfolios rather than *m-learning*. Also impacted by executive changes at the university following a period of funding shortages.

Table 10 – Project Stages University B

At point A, the project commenced with links to the global network - a feature from the start. At point B, technology choice, the local network asked the global network in the form of IT Services but centrally there was little knowledge to help. Pilots took place in all five institutions (point C) and choices over technology were made. Implementation (D) and Final Project service (E) occurred as the local network tried to get students to engage with the devices with plenty of support from central IT staff. Input from the local network to the global network was maintained through a key individual who led the Technology Enhanced Learning team (TEL). Embedding did not occur because of student and tutor perceived failure of the assessment application and the funding shortages within the institution. However, the degree of attachment of actors in the global network remained high throughout the project. There are many strong points of passage between the local and global network so the institution has a much greater chance of exploiting the results of projects like this as it has the supporting mechanisms to capture the ideas in central strategies.

In summary, University B appears to have built good links between the local and the global and would appear well placed to utilise the lessons from project MED. However there did not appear to be any active *m-learning* projects at the time that project MED completed, so risk of those points of passage eroding over time must remain.

8.3 University C

University C was a long established medium-sized university with a strong reputation for technology and innovation. This university taught a variety of health subjects with a focus on nursing and physiotherapy within the project. The institutional IT structure was centralised with some faculties having their own local support team but the majority of services provided centrally. Central IT Services were closely involved with the project and provided the key IT representative to the project MED IT group. In addition to supporting the work of the project within University C, IT Services also supplied a help-desk which was first-line support for all the students with mobile devices issued through the project, across the five universities. This was a service that the other four institutions made a financial contribution to and a good example of the capacity-building strategy that characterised University C's approach to project MED.

8.3.1 University C mobile strategy

Consistent with other institutions, no *m-learning* strategy existed at the start of the project and Central IT Services saw the project as an opportunity to learn about *m-learning* and the problems involved. The same team already ran more than 300 corporate mobile devices used by executives, managers and senior academics. They also made use of text messaging, particularly in engaging with students who were about to come to the university, using text extensively to keep contact in the period between getting A level results and registration, believing this helped with better induction and retention during the freshman period. IT Services were concerned about the proliferation of mobile solutions and

applications so wanted to create a position for someone who would oversee the implementation and try to bring some order to the situation:

> "And the post we put in for was this role of mobile technology advisor which was, we had all sort of corporate users, a variety of mobiles, there wasn't any centralised support for it and people were starting to do things for teaching and learning as well so it was actually, the job itself was quite an open remit, it was just support this E strategy vision of a wireless enabled campus" ***User Services Manager, IT***.

In this university it is interesting to note that the team were driven by both business needs and learning and teaching needs and the same team oversaw all mobile-related technology within the institution. In many institutions, these two aspects are often divided with *m-learning* seen as part of learning technologies and corporate phones usually associated with the telephony support team within the institution. And University C also felt that with more and more corporate smartphones there was synergy with *m-learning* applications:

> "People were constantly complaining about new phones, so really the role of the job was to try and smooth the introduction of smartphones and put in place better business applications and systems" ***Mobile Technology Advisor***.

The department also placed mobile as part of its customer support services rather than as part of its technology group:

> "And most people would have put mobile technology in with the techie lot. And I was quite keen that it didn't go in with technology because I think the problem was with the customer facing issues with it" ***User Services Manager, IT.***

As with University B, IT Services saw that *m-learning* was something they would eventually have to get to grips with and viewed the project as a great opportunity to learn about the technology and its associated issues and build future capacity. It appeared IT Services provided good support to the project and

this was confirmed by staff in the faculties working on the project who had contact with the IT team and their mobile technology expert from the beginning:

> "We've had good support from IT Services from the start and they even support me when I present the project to other parts of the University" ***Site Lead***.

8.3.2 Points of Passage

In terms of IT Strategy, there was a clear point of passage between the project and the institution. The individual who provided mobile technology support to the project also provided it for the institution and reported into a manager who had a seat on the IT strategy board. So expertise flowed from IT services into the faculties that were trialling the project software and results were fed back giving the opportunity to influence the institution IT strategy. An example of the benefits of this approach is that University C was amongst the first UK institutions to implement CampusM, a student portal accessible via smartphones. The same individual was also a prominent member of the five institution IT team which the project ran at the program level and also managed the first-line helpdesk system, which was provided to all the five partner institutions. The IT department thought advantages had arisen from hosting the help desk for the five institutions:

> "And it definitely has worked out. By hosting it I think we got a much better understanding about it all when it's together, device and learning application. So, I think if you look at the bigger mobile technology thing, there has been quite a lot of learning" ***User Services Manager IT***.

As in University B, there was also a prominent learning and teaching fellow (also the Site Lead) located within the School of Health who also helped spread some of the project lessons into the teaching and learning strategy. And they felt that that was the appropriate place to do this:

> "Now, if we are going to start trying to encourage it, I think that (the strategy) has to be the place to do it" ***Site Lead***.

They saw their objective to disseminate the *m-learning* experience into other faculties:

> "And the objective was taking mobile learning across the institution, which I haven't really had that much success with, largely because of the problems we've had with the project technology" ***Site Lead***.

Thus due to technology problems, the impact of the mobile assessment application on other departments per se was minimal. However they had a seat on the teaching and learning committee for the university so rather than abandon any push because of the project difficulties, they looked for other opportunities:

> "What I did was I looked at what we were doing that was successful with mobile technology that the rest of the University could do. We did lots of work around audio reflection, student self-assessment and audio feedback. And that has been distributed across the university and is being distributed across the university" ***Site Lead***.

This shows that there is a point of passage into the overall university teaching and learning strategy and where projects have successes there is an opportunity to spread and embed new practice, complementing the point of passage that exists in the IT department.

The university appeared to have strong links between the IT strategy, Learning and Teaching Strategy and the project. One further interesting comment came from one of the tutors who was working on the project who, although frustrated by the technology problems, felt that there was considerable knowledge transfer from the experience:

> "But I think actually bringing mobile devices into universities, showing tutors what they can do provides a spur to your imagination and how you could use it" ***Tutor***.

So perhaps there is an invisible point of passage into teaching and learning, a longer-term influence which might pay back in the future. There is not sufficient evidence from this research but it could provide another research opportunity for the future.

8.3.3 Embedding

As with University B, Embedding did not occur in terms of the mobile assessment application. The project was handicapped for the same reasons as the other institutions with poor student response to the slow devices when compared with the latest smartphones. However, there was evidence to suggest that the project had a lasting influence on the institution (Observed through researchers' presence at IT meetings and project conference), notably in the use of audio feedback, the CampusM student portal, a blog site for mobile aimed at students and also some positive experience with the project devices that helped reinforce the benefit of using mobiles for both IT and academic staff. An early trial in the project where students had access to an e-portfolio on a device was well received and latterly the project undertook a trial for students with learning disabilities who found the devices very useful as tools to help them organise their learning, particularly for those who struggled with time organisation and keeping track of tasks. Several comments emphasised the learning gathered from the project:

> "One of the things I'd like to think will come out of the project is that we will know more about mobile learning" ***Tutor***.

And from IT Services:

> "It is a positive experience; we need to start implementing it for teaching and learning here. The main benefit at the minute is just seeing how all the systems, the architecture and stuff tie in together so that we can then decide what works and what doesn't" ***Mobile Technology Advisor***

And:

> "I think we all believe here in University C that this is where we're going. I think this project has been a bit ahead of its time really" ***User Services Manager IT***.

And from the teaching and learning perspective:

> "I think certainly we probably wouldn't have thought of anything mobile before so it has kind of brought them into our lives and made them part of our routine practices as lecturers we use them. So from that point of view I think it's good and I think as the tools develop and the things you can do on it develop, then it will start to embed" ***Tutor***.

In terms of some services such as making various aspects of the VLE or student portals accessible via mobiles, IT Services felt this was very much their aim. They did however feel that true mobile learning applications such as that developed by the project had to be driven from the subject specific need:

> "it's got to come from the school that has a learning and teaching need to do it" ***Mobile Technology Advisor***.

The Deputy Vice-Chancellor felt that Universities were unprepared for what is coming in terms of students who used technology to learn, who perhaps would not respond to the traditional models of university teaching. He thought universities including University C were still building large lecture theatres to support the existing model. He thought they needed to revamp their learning and teaching strategy to be able to respond to new challenges and had created a:

> "..Statutory Committee to enable us to be able to respond to those kind of issues in the next five years because, we do think at present we've got a muddled philosophy about learning" ***Deputy VC***.

This view of a changing education environment where technology challenges traditional lecture-based environments is supported by some more recent texts on

the future of higher education (Bradwell, 2009, Christensen and Eyring, 2011, Johnson and Brown, 2012).

In terms of the future of the technology, IT services felt strategy was about enabling student-owned devices:

> "The problem with this assessment application is that we're very locked into one device platform and I can't really see it being workable that the universities can provide students with mobile devices" ***Mobile Technology Advisor.***

And:

> "The devices last two years at most and really rather than being prescriptive about what students use, we need to become more device agnostic and say, well, these are the systems, you access them how you want to " ***User Services Manager IT.***

Despite the lack of embedding of the mobile assessment tool, evidence of a stronger mobile computing strategy following the project is apparent with perhaps the greatest range of mobile access to university systems amongst the five project partner institutions. Students have access to the institutional VLE, E-portfolio and student portal as well as a number of text messaging services. In addition the university has a website and blog specifically dedicated to informing students and staff about mobile access to systems. The presence of an influential point of passage in terms of the mobile technology advisor has brought this about, marrying the project experience with wider institutional needs.

8.3.4 ANT Analysis - University C

Project History

When the project was bid for, it had senior backing within the institution and also an objective from both the Deputy Vice Chancellor and Senior IT Management to use the project as a vehicle to inform IT Strategy. IT Services appointed a Mobile Technology Advisor whose remit included supporting the project but also a requirement to develop a mobile computing strategy for the whole institution. Once the work started in earnest, the global network was kept informed of progress but the technology choice was undertaken mainly with the other four institutional partners and external providers such as network operators and software developers. Before final technology choice, trials took place with mobile devices within University C and also within the other four institutions involved in the project, IT services and, particularly the Mobile Technology Advisor, actively supported the trials and indeed helped develop software for a prototype assessment tool. The trial was deemed a success within University C and in many ways represented a high point of the project for them. Taking into account the feedback from the trials at all the institutions, a device was selected, final development partners were chosen overall and procurement was handled by the lead partner, University A. There was some evidence that University C was not completely happy with the final project choice – not the device, but certainly the software platform. University C already had an institutional E-portfolio so the fact that the solution was incompatible with theirs caused concern (although this was partially addressed later on by allowing export of data from the mobile application to other E-portfolios using LEAP2A standards

(www.leapspecs.org/2A). At the point of mass procurement, University C also came forward with the offer of providing a help desk for the five institutions, something that IT Services saw as a strategic opportunity to build even more capacity from the project. Once procurement was complete, students were issued with devices and the application was installed when it became available (application development lagged behind issuing of devices). Students experienced numerous installation problems with the devices that resulted in a low take-up of the application. During this time there was considerable linkage between the project and central IT Services through the Mobile Technology Advisor and running the help desk. Central IT Services were regularly informed of the issues and problems. The project took the decision to recall the devices and pre-install the software before re-issuing them to students. The subsequent use of the devices was not widespread because tutors and students were partially influenced by their prior experience and the slowness of the devices compared unfavourably with the newer smartphones that many students had begun to acquire. Finally, the end of the project arrived and the university decided not to continue with the mobile assessment application developed through the project This was partly down to experience but also due to some incompatibilities with the institutional E-portfolio, lack of funding and the feeling that any solution must be based on using students' own devices. Although the project solution was not embedded, there was clear evidence that the mobile computing strategy of the institution was much transformed by the experience of the project and most institutional systems that students access (such as VLEs and E-portfolios) were made accessible via smartphones. The Mobile Technology Advisor

remained a key figure in the implementation of all aspects of mobile computing within the institution.

Law/Callon Trajectory – University C

This is represented by the following diagram (Figure 13) and corresponding table:

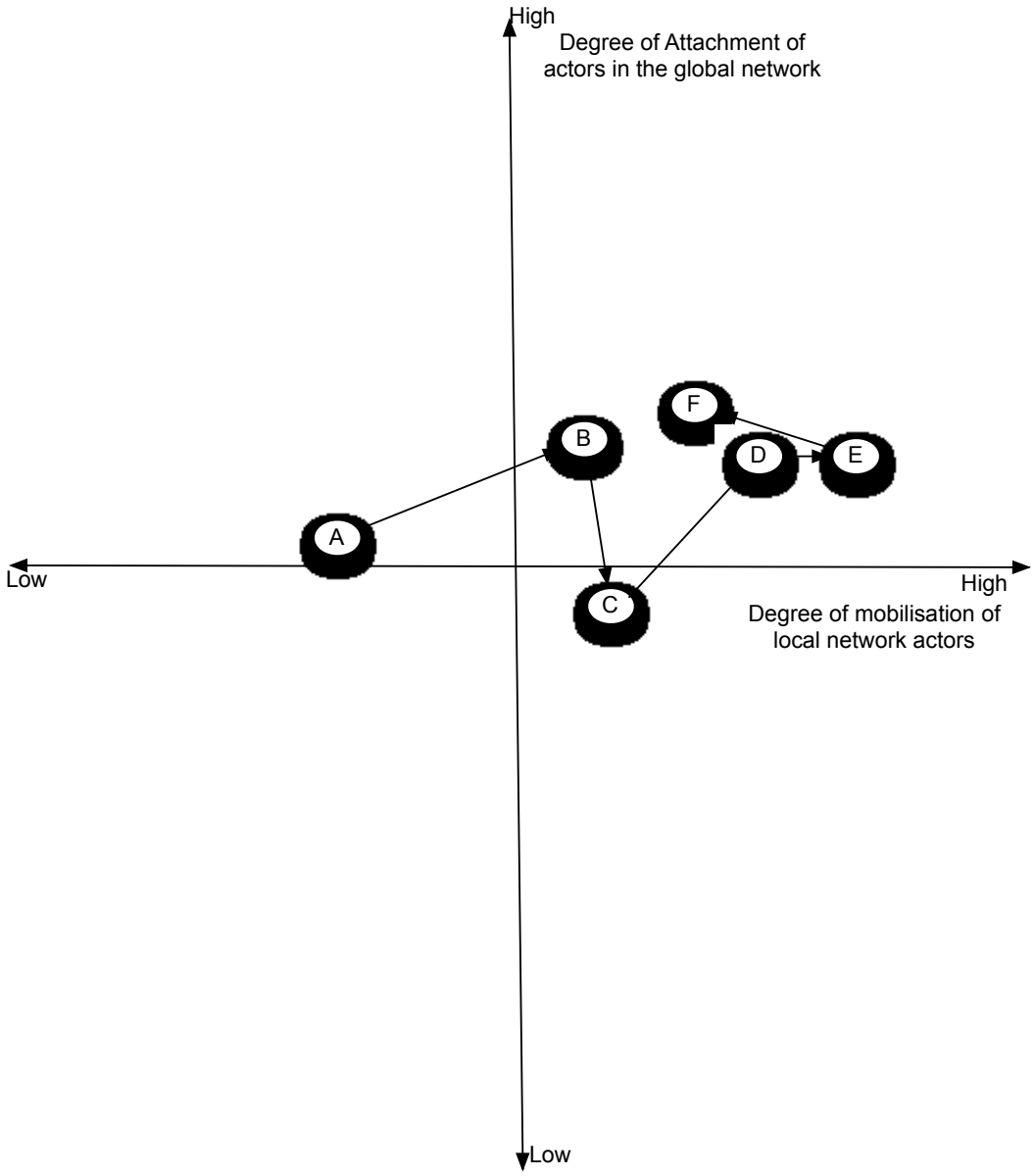

Figure 13 – Law/Callon Trajectory University C

	Event/decision	Local consequences	Global consequences
A	Initial idea	Resources to undertake the project. Meetings arranged with IT Services to build support	High-profile project - opportunity to learn more about *m-learning*. Input to IT Strategy actively sought and encouraged. Appointment of Mobile Technology Advisor.
B	Pilot	Try out devices with groups of students to gain initial feedback. Initial feedback good	IT Services implement forms based assessment tools which can be used in the pilot.
C	Technology Choice	Seeking guidance on best practice both within the university and across other partners. Some tension with lead partner institution on choice of software platform (E-portfolio)	Keeping a close watch on developments and central IT Services involved in overall partner IT group. Unhappy over choice of E-portfolio software
D	Implementation	Deployed but considerable problems due to complexity of device setup and slowness of devices	Closely involved through Mobile Technology Advisor and well aware of all the issue through running the central help desk.
E	Final Project Service	Setup problems resolved but students frustrated by slowness of devices prevent widespread deployment. Many cohorts using paper systems.	IT Services aware of issues as help desk activity extremely low. Attention turned to what other services could be launched on students mobiles such as CampusM

	Event/decision	Local consequences	Global consequences
F	Embedding	Can't continue once funding runs out as devices now too slow and no budget to replace. Focus on embedding concepts from the project rather than embedding the project solution.	Reports back into teaching and learning strategy (some success with using audio feedback) as an institution-wide project. Project becomes input to longer-term mobile strategy. Short-term priority is services available via mobile - examples appear of institutional wide mobile access.

Table 11 – Project Stages University C

When the project started, both the global and local networks had a high degree of attachment to the project, the global network also seeing it as an opportunity to develop mobile technology strategy for the institution. The pilot service (B) was successful, the global network offered support by developing a simple assessment application on which students gave positive feedback. At point C (technology choice) both the local and global networks were disappointed that the software technology choice was (at that time) incompatible with the institutional E-portfolio but nevertheless accepted the decision and prepared to deploy the project devices to students. Indeed the global network offered to provide a project-wide helpdesk for the five institutions, seeing this as a further opportunity to learn from the project. The initial attempts to use the devices were largely unsuccessful as many students saw the installation process as too complex. Through phase E, devices were re-called and re-launched to students with pre-installed software but by then, few students were willing to engage with the devices, not helped by the growing obsolescence of the technology. When it

came to stage F, embedding, the Health subjects did not see it as viable to continue with the existing application and there was no budget to procure new devices for students. The local network's enthusiasm for mobile technology was placed on-hold but the global network used the project experience to increase access to institutional systems via mobile, a strategy that continues.

In summary, University C is not able to continue the assessment project but has used the project to enhance its capability within the global network to offer more mobile access to services. A strong point of passage was established between the project (local) and the university (global) networks in the form of the Mobile Technology Advisor and the User Services Manager which has built capacity from the outset.

8.4 University D

This was different to the other partners. The institution was much smaller and taught a limited range of subjects with major strengths in health and teacher education. Although very interested in the *m-learning* aspects of the project, its main aim for being part of the CETL was to work in partnership with larger institutions. It saw this partnership working as a strategic opportunity to raise the profile of the institution and also enhance its considerable expertise in assessment in practice gained mainly through its excellent reputation for training students in occupational therapy. Funding for the project was loosely based on numbers of students participating so, as a smaller university, this institution had a lower share of the CETL funds. In the other institutions, the project had funded Teacher Fellows on a full-time basis whereas in this university the funding was insufficient to do this and thus the project was embedded as a portion of a number of people's roles. This is worth noting given that the dedicated Teacher Fellows had been a point of passage in at least two of the other institutions (see University B analysis for a good example). In terms of IT Services they were closely involved in the project from the early days and the small size of the institution enabled closer working relationships between the project and any central services. In effect the possibility of distributing IT support in the ad-hoc manner of University A (or University E discussed later) between faculty and central services was not an option and those IT staff involved on the project were very much part of a single IT services organization.

8.4.1 University D mobile strategy

The university would openly admit that it was not investing in mobile computing prior to the existence of this project - the only activity was a number of corporate devices that were issued to senior staff. IT Services was split between infrastructure and learning technologies with representatives of both parts involved in the project. Learning technologies was part of a student-learning department, which also contained libraries and ICT, and was headed up by a Dean of Learning Development. Like many institutions then there was a clear split between staff working on learning technologies and those working on ICT in general, which is a feature of problems in two of the other institutions. But this university was small, both learning technology and ICT had common senior leadership and staff were all well acquainted with each other, so good working relationships appeared to compensate for any possible divisions in responsibility that the structure imposed. At an early stage of the project an experienced learning technologist was allocated to the team and they played a prominent role in the implementation and also served on the five institutions IT team. Someone was also brought in from the ICT team who had experience of mobile computing, albeit mainly with issues such as email and web browsing from senior staff who were issued smartphones. The close working relationships between all the parties is perhaps best summed up by the following quote:

> "We had the advantage of being quite a small university; we can mobilise our troops a little bit more quickly than some other universities. So organising a meeting we seem to be able to do quite quickly and get everybody informed as to what the situation is and what issues there might be" ***Site Lead***.

8.4.2 Points of Passage

Evidence gathered during interviews showed there was a close link between the project work and the Dean for Learning Development who had ultimate responsibility for the University E-learning and ICT strategy. The Dean was clearly quite determined to look for mechanisms that would capture lessons from the project:

> "Because that's what happens with IT research projects, the learning gets lost and then it is repeated by the time we get to a point where you can really mainstream the technology" ***Dean for Learning Development***.

To guard against this the Dean created a mobile futures group whose role was not only to take lessons from the project, but to develop new ways of learning through technology and new forms of learning spaces such as student hubs with wireless connectivity as opposed to rooms full of PCs. Those involved in the project plus key ICT and E-learning staff, as well as the Dean plus other senior members of the institution populated this group. The Dean also felt that it was important to gather ideas rather than formulate a strategy:

> "so that futures group is about mobile learning and my task is to ensure these things can happen because mostly they're driven by earlier adopters not by a strategy" ***Dean for Learning Development***.

From the perspective of the project the existence of this group was confirmed and was an encouragement that some of the experiences might be carried forward into future strategy:

> "Very recently a group has arisen, which is looking at this" ***Tutor***.

There was a mixed view about whether the work of the project was well understood by other parts of the university – there didn't seem to be an

equivalent learning and teaching network which existed in some of the other partners such as university B:

> "Yeah it is tough to say really I mean I have been to presentations within the university they've talked about the project and the work that's been involved in that but I don't think there is the level of awareness that there could be." ***Tutor***.

But others thought that links into the senior management team were strong as the project Site Lead was a member of various strategy teams and groups:

> "X tends to feed that type of information back to senior management level. He has had discussions with me about how we would enhance this technology and what our future strategies might be and then I am a member of different groups within the university groups like future technologies groups where we discuss this so we've got a way of feeding information back and we've got senior members of staff on that team" Dean ***for Learning Development***.

Given the small size of the institution links between the various groups, IT, Learning technologies were strong if perhaps informal in nature. The central IT team felt they could have contributed more to the project at an earlier stage as they felt the project staff and learning technologists could have benefited from their knowledge and avoided some issues:

> "I think there was a feeling that if IT had brought in at an earlier stage that might have been beneficial so picking it up when maybe some of the questions that could have been asked earlier weren't asked" ***Learning Technologist, Health***.

And from another source:

> "Yeah I think there was a strong feeling in my department was that a lot of expertise they could have used earlier and they did use us on middle to latter stages but they could have used; I think there was a feeling that, didn't they realise that we know a lot about this?" ***IT Officer***.

This is perhaps another illustration that the separation of IT and learning technologies can lead to some fragmentation where perhaps the potential synergy

between the two sets of actors was not achieved. The need to work together more closely was recognised:

> "But for me the greatest lesson is shared thinking so IT is not just ahead and doing what it thinks and not other groups within the university going ahead and doing what they think. But working together, more synergy in that" ***Site Lead***.

However in making these judgements consideration must be given to the relatively small size of the institution, the relative failure of the technology in terms of its impact on students and institutional IT priorities. In terms of rolling out to other departments the overriding feeling was:

> "I'm not quite sure whether we've got anything at this stage that would be of real use to anybody else and within the other faculties." ***Tutor***.

University D perhaps lacked the formal structures to create points of passage between the project and the institution, relying on its relatively small size to compensate. There was no single influential individual as with University C who was able to take hold of mobile computing and turn it into a strategy by using the project as a launch pad. But the need for points of passage was well understood by the institution senior management and they had put in place the futures group to address that need:

> "It's a mobile futures group. So it's more of a Blue Sky Group because we don't want to lose that learning but on the other hand there's no way next year that's going to be embedded in… because we're not at that point with the technology or the curriculum that's offered here so I want to maintain the learning and keep it alive as we move other things so it becomes possible to embed mobile technologies within lots of learning spaces for students." ***Dean for Learning Development***.

8.4.3 Embedding

It's very clear that the institution was unlikely to embed the application once the early student experience was so disappointing. The institution had also entered the project for strategic partnership reasons and although it was willing to consider embedding, this was a lower priority goal. However senior management were keen to learn from the project and certainly open to *m-learning* within their longer-term strategy. The embedding aspect of the project then is lessons learnt and impact on future strategy and a number of quotes support that view:

> "One of the main benefits is that it helped raise our awareness of the use of mobile technology in education and its helped us realise perhaps what some of the benefits might be in and how we might be able to use it in the future but also I think part of this project has really helped us understand what the pitfalls might be and the lessons we can learn from how we've tried to roll out so far" ***Site Lead***.

And in terms of future strategy:

> "I think we're still on that learning curve of seeing how well that translates. I personally think it has tremendous potential and I think as yet the technologies are not easy enough for students just to quickly engage with them" ***Tutor***.

There was consensus that the idea of buying students devices and installing applications on them was not a viable future, and that web based application were the way forward:

> "And so if we were to do the whole thing again I think a lot of us would strongly say let's move along the web-based route instead of a mobile client; and maybe we would have looked at different options in terms of mobile device provision as well" ***Learning Technologist, Health***.

And:

> "My understanding is that from the E-learning point of view that we should be enabling the technologies for the students' own devices and I

> think in IT we're in agreement with that. So we put in systems and we make our systems mobile friendly so a student can turn up with whatever device they have and it will work and I think that is the vision" ***IT Officer***.

Creation of learning spaces were very much seen as the future direction, a student-centric view, which is consistent with recent government HE strategy (Great Britain Department for Business Innovation and Skills, 2011):

> "my view is students will bring more mobile devices with them and that we will switch away from fixed IT labs and maybe have laptops with docking stations and things for and slowly a space will be created where students can use their own devices" ***Dean for Learning Development***.

But no clear strategy had emerged from the project with various reasons cited which included the difficulty in predicting technology trends and that *m-learning* would be a product of E-learning strategy anyway:

> "I would say it's not really a strategy within IT we're, we're well aware that something, something needs to be done with it and what we're sort of looking at it along with other areas like E-learning" ***IT Officer***.

Furthermore:

> "I think it's a very challenging space to work strategically because you know you can always be waiting for the next version and thus never make an investment or that you see your manager and don't have enough a handle on the technology futures" ***IT Officer***.

The Dean for Learning Development felt student learning would drive the strategy and not IT, again emphasising a student-centric view:

> "It's no good me investing because I'm responsible for making sure we do invest in the right things and understand student learning and how students behave in reality is my concern not what I might like them to do" ***Dean for Learning Development***.

As to the actual assessment application, others thought that although this was not going to embed on this occasion, the idea had longer-term embedding possibilities that were recognised by the university:

> "it seems logical to think of the mobile device of some sort to capture assessments and get those back to universities. I just don't think it will be with the systems that we're currently using" ***Tutor***.

And at a senior level the institution was aware of the possibilities of mobile devices that could save costs:

> "I've just had my PDR with the Dean and one of the things we're looking at the moment is the very costly way in which we support students on placement because, they're still using paper based systems, still visiting people as a matter of course for thirty minutes on every placement" ***Site Lead***.

There is evidence that actually some ideas from the project did embed in other areas apart from *m-learning*. The early pilot of the mobile device had included some training videos that students could use to help them with more complex clinical procedures in areas such as physiotherapy. This had caused a stir in the institution and practice had spread into other areas:

> "and now more and more staff are looking at different ways of using videos... and some staff I would never, ever put money on... ... championing that but they are and sometimes linked to assessments so there are now some assessments on Blackboard... completely independent of the project but you watch this video and ask these questions so... ... that's an assessment, so it's made people think differently about learning" ***Tutor***.

Given that the institution has not embedded the application and does not appear to have advanced its *m-learning* services as a result of the project, all those involved felt that the learning was going to have a longer-term influence, the only question being whether that lack of a formal link to a new strategy would

result in the knowledge being lost. The project lead felt that that it had been a positive experience, far better than not being involved at all:

> "So if we'd actually sat back for five years we could've said well we haven't made any mistakes in these areas but neither would we have addressed them at all" ***Site Lead***.

At the completion of the project and subsequently, it is difficult to find evidence that *m-learning* has advanced further in the institution: there were no plans for a mobile portal such as CampusM for example. There have also been changes in personnel at a senior level in learning and IT. There was also no strong individual acting as a point of passage as in the case of University C, so perhaps these two factors, the apparent lack of a formal mechanism to take IT research into future strategy and changes in personnel - have hampered progress.

8.4.4 ANT Analysis - University D

Project History

When the project was bid for, it had senior backing within the institution but the main strategic focus was the value of the regional partnership with several large institutions. A learning technologist was appointed to the project to look at *m-learning* issues. Before the major procurement of devices by the lead institution, University D conducted a pilot service on some initial devices and also provided some extra facilities to students through customising some video training aids. This customisation involved the global network in the form of IT Services who started to get involved in the project, with perhaps a feeling that they could have been brought in sooner. The trial of the device was successful with the additional training videos very well received. The practice of using video in this way (albeit

not on mobile) is something that percolated to the global network through informal learning and teaching groups. This initial pilot was probably the high point of the project for University D from the *m-learning* aspect. At this point, the technology choice for the whole project was decided mainly in conjunction with the partners and external providers, such as network operators and software developers. Taking into account the feedback from the trials a device was selected, final development partners were chosen overall, and procurement was handled by the lead partner, University A. At this point also, the Dean for Learning Development set up a mobile technology futures group with the expectation of capturing the lessons learned from the project – a clear link between the project and the global network. Once procurement was complete, students were issued with devices and the application was installed when it became available (application development lagged behind the issuing of devices). Students experienced lots of installation problems with the devices that resulted in a low take-up of the application. During this time there was considerable linkage between the project and the learning technologist who was supporting them. The project took the decision to recall the devices and pre-install the software before re-issuing them to students. The subsequent use of the devices was not widespread because tutors and students were partially influenced by their prior experience and the slowness of the devices compared unfavourably with the newer smartphones that many students had begun to acquire. Finally the end of the project arrived and the university decided not to continue with the mobile assessment application. This was partly down to experience but also lack of funding and the feeling that any solution must be based on using students' own devices and web-based applications. Although a mobile technology futures

group had been set up, there was no apparent evidence that the project lessons were captured and no obvious push by the institution to open up access to systems through mobile.

Law/Callon Trajectory – University D

This is represented by the following diagram (Figure 14) and corresponding table:

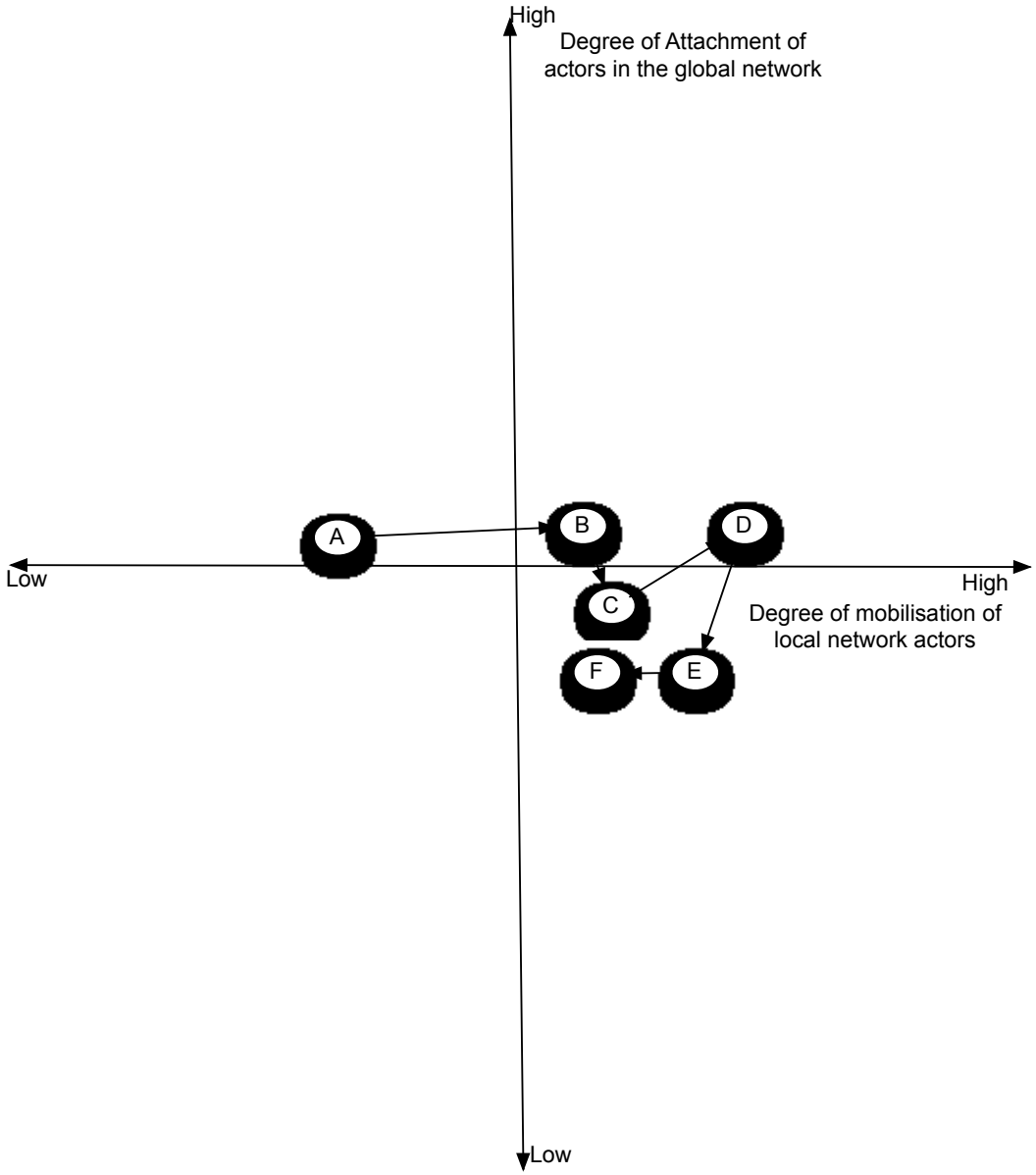

Figure 14 – Project Trajectory – University D

	Event/decision	Local consequences	Global consequences
A	Initial idea	Resources to undertake the project. Meetings arranged with senior management to build support	Partnership with larger institutions is key driver. Appointment of learning technologist to support project
B	Pilot	Try out devices with groups of students to gain initial feedback. Initial feedback good	IT services staff brought into help to develop video clips for the devices. Use of video clips picked up by global network as a teaching innovation.
C	Technology Choice	Seeking guidance on best practice both within the university and across other partners.	Central IT Services perhaps feeling that they could have been asked to contribute more to this. Learning technologist part of partners IT group.
D	Implementation	Deployed but considerable problems due to complexity of device setup and slowness of devices	Learning Technologist closely involved. IT Services kept aware of the issues. Dean of learning initiates Mobile Futures group for university wide ideas capture
E	Final Project Service	Setup problems resolved but students frustrated by slowness of devices prevent widespread deployment.	IT Services aware of slow take-up and by now have no expectation that the project application will be embedded anywhere.
F	Embedding	Can't continue once funding runs out as devices now too slow and no budget to replace. Focus on developing other opportunities from the partnership.	Mobile Futures group still live but expectation shifts to making web based services available from mobile. No real evidence of focus on this i.e. no high visibility services available to students through mobile.

Table 12 – Project Stages University D

As the project started, both the global and local networks had a high degree of attachment to the project - the global network also seeing it as an opportunity to develop partnerships for the institution. The pilot service (B) was successful, the global network eventually getting involved, offering support by developing training video clips which students gave positive feedback on. This use of training video clips represented a technology highpoint for the project and the practice was introduced into other parts of the institutions. At point C (technology choice), the learning technologist was involved in the device choice which was led by University A, but the global network in the form of IT Services felt that their expertise could have been used more. The initial attempts (D) to use the devices were largely unsuccessful as many students saw the installation process as too complex. Through phase E, devices were recalled and re-launched to students with pre-installed software but by then students were unwilling to engage with the devices, not helped by the growing obsolescence of the technology. The global network initiated a Mobile futures group with the aim of capturing lessons learned from the project with representation from both the project (local network) and key staff from around the institution. When it came to stage F, embedding, the health subjects did not see it viable to continue with the existing application and there was no budget to procure new devices for students. The local network's enthusiasm for mobile technology was placed on-hold and the global network focused on other priorities with no real evidence emerging of new initiatives in *m-learning*.

In summary, there were good links between the local network and the global network in University D although they were perhaps a bit weak at the start of the

project with central IT Services feeling they could have contributed their knowledge to the device selection process. Once the project completed, although a Mobile Futures group was established, it lacked focus because there were no mobile related projects underway. Thus capacity-building may be weak, particularly if individuals who had been involved in project MED were to leave the institution. The small size of the institution is an advantage in that despite the lack of capacity building, it is difficult to envisage a situation where projects can be developed independently of the global network, an issue which is more likely to occur for other larger project partners, such as universities A and E.

8.5 University E

This was a medium sized university, which taught a diverse range of health subjects including nursing, midwifery, social work and operating department practitioners. The university had a variety of reason for getting involved with the project with a desire to experiment with mobile technology only part of it. The major reasons were the partnership with other institutions and an opportunity to develop its already leading work with involving service users with health student education. This service user work is a separate strand of the overall project and for the most part is independent of the mobile technology so will not be discussed further in this thesis. The project provided funding to a number of Teacher Fellows who promoted the project and a number of PhDs. One of the PhDs was a specific investigation into the infection risks presented by the mobile devices from the project, something that a number of Hospitals and Primary Care Trusts were concerned about and a research area that had not been widely-addressed at this point.

8.5.1 University E Mobile Strategy

Like other institutions, no *m-learning* strategy existed at the time the project started. As central IT staff honestly commented:

> "for heaven sakes we're only just looking at setting up a proper text messaging service" ***IT Officer***.

An opportunity to learn was how the institution viewed the project. It had a somewhat fragmented structure rather like University A. Some faculties had

significant sized IT teams and managed their own servers and desktops locally whereas others had minimal local IT representation (apart from E-learning support) and relied on the central organization for all their IT infrastructure. There was an institutional VLE and E-portfolio available, which were supported by the central IT team, with learning technologists located within the faculties. Those faculties and schools which didn't have their own IT team would, as a minimum, have some form of local learning technologist. The project was focused around the School of Health which had an IT team of five people with its local team leader a prominent figure within mobile aspects of the project and a representative on the five institution IT group. A liaison person was nominated within central IT Services who would arrange for any support such as user authentication needs. The IT officer nominated also had considerable experience of mobile phones, such as Blackberry, having been involved in supporting corporate devices for senior staff.

The central IT services view of the *m-learning* project, was illustrated well by the following quote:

> "We're a fairly small service and we're not got really got into the mobile stuff yet, I'm stunned that the VLE supplier hasn't done more on the mobile level yet and to an extent I've said it at project meetings, the mobile assessment project got very tied up at first with finding the mobile supplier and all this that and the other and to me that's irrelevant: what about the strategy and the VLE? Surely that's more important" IT ***Officer***.

They strongly felt that the project had been too supplier and technology-led as opposed to being considered more from an end-user perspective. In terms of penetration into the department, they didn't feel that it had penetrated into strategic IT thinking.

> "Well I mean apart from myself and X it hasn't really impacted much on our IT department" ***IT Officer***.

They had tried to get the head of IT involved in the project on a number of occasions:

> "X is our head of IT yes. And he's been to one or two of the Project meetings we've dragged him along because he needs to be sort of aware of what's going on. - I'll keep nudging him saying you know this is happening" ***IT Officer***.

In terms of support from IT to the project the main area had been around identity management so students could sign-on through the mobile device using their student identity number and password and this had been successfully achieved. The central IT team hadn't been brought in particularly early into the project and their involvement only started when the devices had been procured by university A and distributed. The faculty-based staff didn't think it was appropriate to involve central IT any sooner than when they were required to provide support in areas such as authentication. As such, they didn't have a major input into the selection of devices or the design of the application. As the faculty-based IT team put it:

> "I think if at that point on deciding what we were going to buy whatever devices we were going to get, if we were trying to involve the institution's IT infrastructure at that point, I think it would probably have over complicated things" ***IT Manager, Health***.

And from the tutor perspective:

> "To get them to be led from what IT were saying centrally, I think that probably would have just over complicated and made things stall at that point" ***Tutor***.

There is an interesting comparison at this point. In this university (E) and University A, the IT staff involved with the project were all faculty based

whereas in the other three institutions they were very much part of the central IT team. Is this a factor which is significant when it comes to embedding the results of the project?

8.5.2 Points of Passage

The points of passage within the project really come down to individuals. There was no evidence of any IT strategy or "learning spaces" style project that would link central IT strategy with the results of the project. There were however links with the overall learning and teaching strategy as the Site Lead for the project (an Associate Dean in the School of Health) was very pro-active in promoting the project around the institution.

Looking at the IT links, a liaison officer was appointed in central IT who would provide support where needed but also took on the role of promoting the project with the central IT team and head of IT. As discussed in the previous section, she had encouraged the head of IT to attend some project meetings so he was aware of what was happening. From the project lead perspective the liaison worked well although the individual concerned retired before the project completed:

> "they've been a great bunch unfortunately somebody who was a real champion for us retired about 6 months ago and she was the person who had come to some of the project meetings and been involved and so there's been a bit of a hiatus there regrouping their staff, they've got less staff than they had. But yes they're interested yes they have some involvement with us. I don't feel we're at odds with them at all; it's for us to communicate with them and so yes that's been a positive" ***Site Lead***.

However no formal forum appeared to exist to import the project results into future strategy. Central IT definitely saw *m-learning* as a learning technology

and felt its introduction and diffusion within the institution had to be teacher-led.

Several comments support this:

> "what the university is doing as a whole it'll come across as being something a little bit more user friendly or something that will be used and is useable rather than something that IT picked off a shelf in store and said this is good use it - which I think sometimes that's the way that central IT in any institution probably works" ***IT Manager, Health***.

And pointedly central IT felt that they were the wrong vehicle to promote the use of *m-learning* technology:

> "getting information out there is not an easy thing. I mean it might be easier for somebody like X and the academic staff to get it out but from the teaching and learning point of view - from an IT point of view trying to get the message across it's like they see IT and go shh don't want to know" ***IT Officer***.

Another point of passage with clear links to executive and senior management did spend a lot of time promoting the project within the institution. From the School of Health's point of view this was an opportunity to be seen as a centre of excellence in *m-learning* and something that they could promote to the rest of the institution. From the project lead's perspective:

> "it's given us the opportunity at the school to start leading in something like that that's going to be used within the whole institution so it may be taken up by other schools with that view that it's not come from central, it's via a school that's already tried it" ***Site Lead***.

At least this was the view before technology problems reduced enthusiasm. Nevertheless the project was widely-known in the institution and its promotion by the site lead was clearly effective:

> "Oh it's definitely raised awareness, there's absolutely no shadow of a doubt about that and X has recently been doing awareness sessions with the Chancellor and the Vice Chancellor and people like that and that sort of level of staff using the devices to demonstrate what they are and the potential" ***Tutor***.

And similarly:

> "Oh there's no doubt that when you get to the senior management level they integrate a lot more so there's no doubt that the project is well mentioned and well aware of within the university, but I think they're just waiting to see what happens" ***IT Manager, Health***.

So points of passage clearly existed both from an IT and teaching and learning perspective but none of those interviewed could point to any clear formal mechanisms for capturing the results of the project and embedding any parts of it in strategy. This would have to rely on informal links unless the technology proved so successful that there was widespread demand to implement from other parts of the institution. One comment seems to sum up this position:

> "I'm not aware of specific meetings they have over there but there are groups that do meet over there with that view not just the IT people but the library services as well have got involvement with it. So I think they kind of get together every now and again and look and see what's out there and look what they're going to spend money on in future years and what developments there are" ***Deputy Site Lead***.

8.5.3 Embedding

As with three out of four of the other partner institutions, problems with the devices and their slow response times meant that the mobile assessment application was not embedded into the institution. The site lead for the project commented:

> "And so I suppose what it's done it's given us a chance to play with those things and see how we could embed them. We haven't embedded them terribly well and in terms of what actual difference it's making to the majority of students here.. it's nil" ***Site Lead***.

There was a clear consensus between the project and central IT services that the only practical way forward in the future was to support applications on students' own devices. A comment from the project perhaps sums up this experience:

> "we need to look at what students bring, what devices they've got themselves and make use of that. I think it's an individual thing isn't it, I think it would be wrong to push it on to all students. There's a fair amount of almost exhaustion and frustration of trying to get the hardware and the software to do what we wanted it to do; and, and some people have disengaged because of that. But we've accumulated a fair amount of experience. A lot of it negative experience but still experience from which you can plan ahead" ***Deputy Site Lead***.

There are some echoes of University D here, frustration with the project technology coupled with a lack of any further *m-learning* projects involving any of the same individuals to build on the project MED experience.

In terms of promoting the findings of the project into the thinking of other faculties and schools it would appear that at least from the *m-learning* perspective, this was not very successful:

> "within the wider university I wouldn't say there's been a great deal of influence. Within the school, people are aware that it's going on. And again I think they just they'll say that's that thing about those mobile devices" ***Deputy Site Lead***.

The Site Lead for the project felt that the poor reception from staff and students to the slow devices made it difficult to promote the concept of mobile learning and assessment further:

> "In terms of the technology, from a strategic perspective within the school is not really knowing how to advise my colleagues in terms of what we should do next because the variables are too huge. So the idea that we would do this and do nothing and just let it fizzle out seems desperately sad. But actually knowing how much it's going to cost, what the bottom lines going to be and what's worth pursuing and what isn't worth pursuing I find very, very difficult to know at the moment" ***Site Lead***.

It would be unfair to say that none of the project results became embedded within the School of Health. The paper-based and online assessments that the mobile assessment application was based around, showed all indications of being continued practice within the School of Health. In another strand of the project, work on service user involvement with student assessment was also likely to continue. The question is really whether any of the lessons learned from the project found their way into future IT strategy. That there were useful pointers to future strategy from the project results was acknowledged:

> " [what] we've had is the opportunity to play with the technology to have the air time and the devices for free and actually play with them, learn an awful lot of things about the technology but also about commissioning, about software, about copyright and ownership of IPR" ***Site Lead***.

In terms of *m-learning*, it was just not a sufficiently high enough priority for central IT services to invest in:

> "I think mobile learning and mobile devices will be at the back of the queue really. But I think once students have got used and staff are used to wholesale use of electronic submission, E-portfolios and other forms of E-learning, then I think that the mobile technologies will be next on the list" Site ***Lea***d.

The institution was keen to sort out areas such as electronic submission of assignments and an institutional E-portfolio and this was dominating the thinking on IT spending. It should also be noted that health student numbers, a key subject area strength within the institution, were about to be heavily impacted by reductions in NHS training budgets. However, there was a general understanding that it would be a step forward to mobile-enable some of the online services to students:

> "myself and X particularly believe that the future is to produce materials for use on students' own devices so if you come along then you've got exactly the same as if you bring your own laptop or you bring your own netbook. If you come along and you've got a device that is fast enough and able to access this material then you've got that as an added perk. Because obviously those numbers over time will grow and grow and grow as more students have smartphones" ***IT Manager, Health***.

One of the issues that central IT were concerned about was compatibility of different systems – this had been particularly highlighted by the e-portfolio software in the *m-learning* application which was incompatible with the university e-portfolio solution:

> "the other thing that we found is the incompatibility of different systems so we've got a system at the moment where it's this mobile phone with this technology with this platform with this e-portfolio and there the twain shall meet so if you come along with an iPhone fantastic though it might be it doesn't work with these systems" ***IT Officer***.

This was another factor that discouraged embedding the results of the project.

Moving forward the university has indeed mobile-enabled some of its online facilities and has a CampusM based application allowing access to information on PC availability etc. It had also been active in trialling systems that allow access to library information via mobile. However it is difficult to trace any link with this work and that of the project. In University C for example, the individual in IT services who supported the project was also the key initiator of their CampusM services and other mobile access facilities. In the case of university E all the individuals are different so there is no clear point of passage between the project and the current mobile strategy. Perhaps it is the failure of the project to get a successful outcome with the mobile application that has caused this apparent lack of linkage to future IT strategy. As one IT person commented:

> "I think the way that funding and projects and higher education works you get these projects and you have to have a boundary around them or else you'd never finish them, but quite often they're not actually gelling together and at the end I think a lot of projects fail, well perhaps not fail, but at the end of the project it just dies because you haven't managed to get the message across" ***IT Manager, Health.***

8.5.4 ANT Analysis - University E

Project History

At the project commencement, the institution was a willing partner because it forged a strategic regional partnership, it allowed them to experiment with *m-learning* and it also provided support to develop the School of Health's interest in service user participation with student training. The project got underway and the university took part in trialling some devices, something that was largely self-contained in the School of Health. This trial was not especially successful – each institution was asked to trial different devices and University E devices proved to be less user-friendly than some of the others. Interestingly this pilot was hardly mentioned by any of the interview respondents whereas it featured significantly in the dialogue with other institutions. Once the eventual project device was chosen and procured, university E attempted to roll these out in a number of health subject areas. At that point central IT was asked to become involved and a liaison officer was appointed (a clear point of passage into the institution IT strategy). The experience that staff and students had with the devices was generally poor and it was decided to recall the devices and set them up so that all the software was pre-installed before issuing to students and staff. Despite these efforts, subsequent usage of the devices was sparse. The liaison officer in IT tried to get her senior management involved in looking at the project but retired before

this had been successful. The site lead continued to promote the project internally but felt that without the take-up by students and staff then it was difficult to take forward any clear strategy when the project ended. There didn't appear to be clear and formal ways of taking the results of the project into future strategy, although informal forums that look at future technology use did exist. Subsequently the mobile assessment application was not embedded although other aspects of the project such as strategies for service user involvement were continued. After the project completed the university launched a CampusM based mobile portal for students although it is difficult to see any clear link between this event and the results from the project.

Law/Callon Trajectory – University E

The development of links between the local network (the project) and the global network (the institution) are shown in the diagram (Figure 15) and corresponding table below (Table 13).

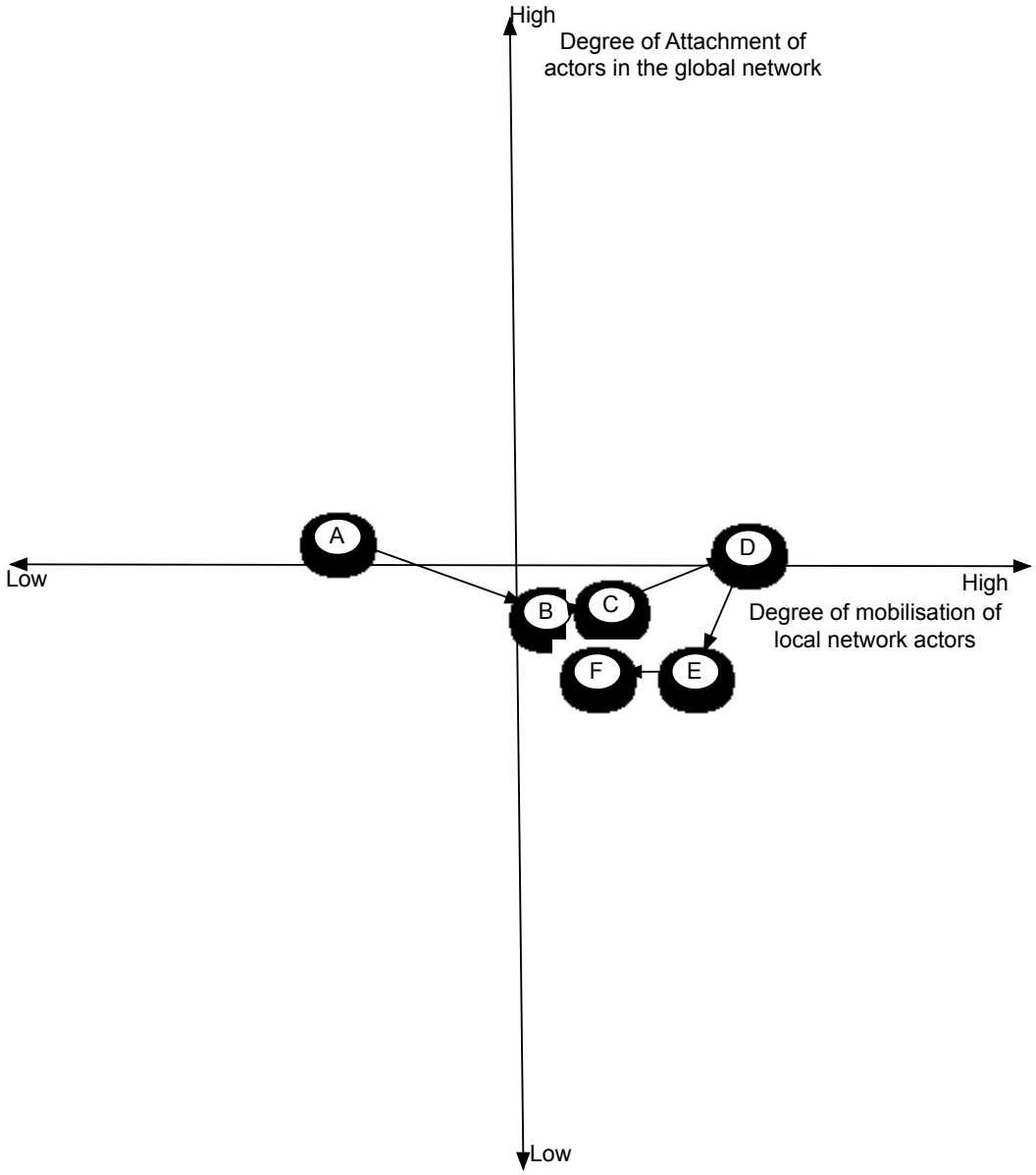

Figure 15 – Law/Callon trajectory University A

	Event/decision	Local consequences	Global consequences
A	Initial idea	Resources to undertake the project. Meetings arranged with senior management to build support	Partnership with larger institutions is key driver as well as opportunity to experiment with *m-learning* and develop service user project.
B	Pilot	Try out devices with groups of students to gain initial feedback. Initial feedback Ok but the pilot device considered difficult to use.	Not really involved at this stage – all support coming from local IT representative
C	Technology Choice	Input from School of Health IT representative who is on the project wide IT group.	Central IT Services not involved in technology choice
D	Implementation	Deployed but considerable problems due to complexity of device setup and slowness of devices	Liaison officer appointed in IT Services to ensure support for project. The liaison officer also attempts to get other colleagues and head of IT interested in the project.
E	Final Project Service	Setup problems resolved but student frustration with slowness of devices prevents widespread deployment.	IT Services aware of slow take-up and by now have no expectation that the project application will be embedded anywhere.
F	Embedding	Can't continue once funding runs out as devices now too slow and no budget to replace. Focus on developing other areas of the project such as service user involvement.	Liaison officer in IT retires leaving a gap in knowledge. Head of the project does try to promote findings centrally at every opportunity. Lack of any formal mechanism to capture the lessons from the project into future IT strategy. CampusM service launched post project but no obvious link back to the project to show that it was a catalyst for that.

Table 13 – Project Stages University E

When the project started, there was a higher degree of attachment from the global network with attractions in partnership working, developing the service user agenda and the opportunity to experiment with mobile assessment technology. A pilot (B) was undertaken with some early devices and the results fed back though the project-wide IT team to feed into the technology choice debate. Procurement then took place through University A and implementation began. At that point (D), a liaison officer was appointed in central IT to act as a point of passage between the project needs and services which central IT can offer such as coordination of authentication services. The liaison officer also undertook promotion of the project to the central IT team as a means of gaining input into future strategy. The implementation stage was largely unsuccessful apart from in a few cases as students and staff found the devices too complex to setup. The devices were recalled and re-launched (stage E) but by then students and staff had disengaged. This disengagement was exacerbated by the slow speed of devices in comparison to new generation smartphones, such as the iPhone. Both the local and global network had little expectation that the mobile assessment application would be embedded and the project just ran to its conclusion. At stage E there appeared to be no formal mechanism to capture the lessons from the project, just informal links between individuals. Subsequently University E developed mobile access portals for its students (via the CampusM service) but there appears to be no clear link between the global and local networks. In other words the CampusM development does not appear to be an outcome that can be traced back to project MED.

To summarise, University E appeared at first to have a stronger outcome through the appearance of the CampusM service like University C but like University A it does seem to be hampered by a fragmented ICT structure, a hybrid of centralised versus local faculty IT provision. Unlike University C, University E does not appear to have taken a capacity-building approach to capture the experiences of project MED into ICT strategy and although a liaison officer was appointed and provided the project with practical support, there doesn't appear to be a sustained interest from senior central IT management. The liaison officer retired before the project completed, further weakening the prospect of an effective point of passage between the project (local) and ICT strategy (global) being established.

8.6 Chapter Summary

Across the five institutions, the actor network analysis has identified a number of issues that need to be considered against both the innovation literature and the Law and Callon global/local model. These issues can be summarised in the following table (Table 14):

Institutions	Observation	Theme
A	Ability to develop mobile solutions independent of Central IT Strategy or Support	Strong local networks producing potentially competing solutions
A, D, E	Lack of formal links between technology projects and both teaching and learning and ICT Strategy.	Absence of point of passage that enables pilot systems to be embedded into core strategy.
C, B	Reliance on key individuals to bridge gap between local IT initiatives and central ICT strategy	The benefits of a key person acting as a point of passage between projects and strategy.
A, E	Fragmentation of ICT responsibility	Lack of a holistic view to enable local and global networks to connect efficiently.

Table 14 – Summary of Project MED embedding issues

The analysis of the field research discussed in this chapter has revealed a number of issues, most notably many of the institutions lacked a clear point of passage between the local *m-learning* project and the global IT strategy and project outcomes varied. Does Law and Callon's local/global model adequately explain these observations or could it be enhanced to help explain the apparent success or otherwise of bottom-up initiated *m-learning* projects? This question is answered

in Chapter 10, which focuses on the contribution to theory that the research has made and proposes areas of further study. The next chapter (Chapter 9) will discuss the key findings from the fieldwork from an *m-learning* perspective and then reflect on the methodology used to organise the research.

9. Discussion and Reflections

This study of *m-learning* through case studies has resulted in outputs in the areas of embedding issues, methodology and actor network theory. This chapter examines the most significant embedding issues and then reflects on the methodology used.

The research started off with the intention of looking at *m-learning* in UK Higher Education – particularly to understand what was different or challenging about it and how would it progress from experimentation to a core offering that would be supported and developed – and become embedded into the university and student experience. In the early stages of the research, the focus was on trying to identify what the issues might be and distinguishing that focus from the wide body of pedagogical research that already existed. After the pilot and main case studies, issues of embedding have been explored in depth in six institutions: the pilot study at Project SMS and the five universities involved in Project MED. Although the main theoretical focus has been Actor-Network Theory, the research has explored some of the issues around introducing *m-learning* and these are discussed both in relation to *m-learning* and innovation literature as a theoretical contribution but also from a practice perspective. This chapter makes its contribution by addressing two key questions: what are the issues with embedding *m-learning* and in what ways might they differ from issues faced when introducing any new learning technology into higher education? It also reflects on what future *m-learning* projects might gain from this research.

9.1 Embedding issues in M-Learning

When the initial field study was undertaken, the contributors from ten institutions were basing their responses on some initial experience with small research projects, but were also speculating on what they felt the issues might be. Some of these issues have not figured prominently in the detailed field study although that doesn't necessarily mean that they can be dismissed. This section will focus on the key issues that have arisen through the field research and will identify those that make *m-learning* different to other IT initiatives.

The business model. At the time of the research and subsequently, it appears that mobile service providers and Education have not come up with a business model which will support students. It is a complex issue and depends on the type of application. If it is informational such as a CampusM service then this can be viewed as optional - the student can get access to the data through other methods. The university can present a case that this access is a choice for the students, a trade-off between cost and convenience. If however, *m-learning* is mandated for assessment purposes, as in the case of project MED or is a necessary aid to field research tasks, then no model existed to support this. The research has already demonstrated the problem of supplying devices to students and what happens when they become obsolete. But conversely the institution finds it difficult to demand that students all have smartphones with certain minimum capabilities and cannot assume that data charges will be bundled into the students' contract arrangements. Perhaps the institution could cover some of these student data

costs (where it forms part of a mandatory assessment), but the mobile service providers do not have a billing system that can cope with this. The students could perhaps claim a contribution back from the institution, but expense systems would most likely creak under the weight of large numbers of small claims. Recently there may be signs that industry is starting to respond to some of these needs with the provision of data-only contracts with tablets such as the iPad and that could alleviate some of the problems experienced in the project MED model.

The debate on business models is perhaps more explicitly captured by this research but other *m-learning* researchers have certainly covered the debate between student owned or university supplied devices (Traxler and Riordan, 2004). Traxler (2010a) takes this a little further, hinting at the possibility of the university issuing vouchers to students to cover study related charges. However this research has illuminated this problem much more explicitly and this has to be seen as a major barrier to *m-learning* applications which become a mandatory part of a student's programme of study. An interesting further area of research could be to talk to mobile service providers and find out why they don't appear to have a strategy for this market and what would cause them to develop one. But the industry has not tended to value long-term customer loyalty in its business model, with customers frequently having to threaten contract termination to get a competitive deal (Ofcom, 2012). Annual churn rates run at more than 25% within the European mobile phone market with word-of-mouth recommendation as a major factor in subscribers changing service provider (Dierkes et al., 2011). With word-of-mouth a significant factor, perhaps churn is even higher in the

student population who are largely borrowing the finance to support their study and thus are highly price sensitive.

How does this lack of an education business model intersect with theories of innovation and technology acceptance? At a fundamental level, IT innovations that offer services closely linked to the needs of users are more likely to thrive and service provider charging plans clearly fail to meet the educational use needs of students and their institutions (Malhotra and Segars, 2005). Lack of incentives to use the technology is also a factor in throttling diffusion of an innovation (Rogers, 2003, Ely, 1990, Billig et al., 2005).

This issue of education friendly charging plans needs to be tackled probably at least at the sector level so that affordable and flexible models can be offered, rather like the bulk discounted licensing deals that are offered into the education sector. Mobile operators will have to start to see this market as both additional revenue and an opportunity to market their services to students as a vehicle to achieve longer-term subscribers. In other words, sacrifice some shorter-term profitability in return for the opportunity to increase product loyalty and revenues in the longer term (Venkatesh et al., 2012), a model which seems to have influenced companies such as Microsoft and Google to develop education friendly email and cloud storage systems. This issue is not unique to the HE sector but Education as a whole. A Unesco conference on mobile learning in education highlighted this issue – 'cost of access is a major inhibitor to use' (Unesco, 2011, p. 21). Perhaps national or even international collaboration and regulation may be needed to resolve this issue.

***Multiple Service Offerings*.** Both the pilot case study and the major case study highlighted the need to provide a mobile environment that students can engage with in a number of ways. Applications and services that were introduced on their own and used infrequently did not foster engagement. Access to other services such as student portals, VLEs and university email accounts were all features that both students and tutors felt should be present. Lack of an institutional ICT strategy that encompassed this range of services seems to be the issue. In a minority of the institutions (apart from University C) had there been an attempt to sit down and produce a strategy which stated what students could expect to be able to access from their phone handsets, i.e. what a minimum level of service would be. It was also not clear if institutions were considering mobile access when they procured new IT systems.

Looking at the innovation literature, ease of use and fitting in with users' expectations are lessons that could be applied here (Rogers, 2003, Cooper and Zmud, 1993). It was clear in Project MED that students expected to be able to access institutional systems such as the VLE and became disengaged when they discovered they could not. The technology acceptance model (TAM) also makes the case that user perceptions are a strong factor in ICT innovation embedding (Davis, 1989) and user perceptions of a device with a limited range of services were poor.

It would appear that the success of *m-learning* to students has to be a cumulative approach (Livingston, 2009), there is no single killer application that will embed.

So in introducing *m-learning* into an institution it follows that this should avoid being limited to one trial application. Simultaneously the project should be linking into overall ICT strategy to say what the institution can also give the students access to on these smartphones – are there quick wins which will enhance their engagement?

The Disruptive Nature of Mobile computing. Even before this research commenced, it was clear that many in an Education setting view mobile devices suspiciously (Sharples, 2002). Students have brought laptops into lectures for many years but tutors will be more suspicious to see students using handheld devices. Handheld devices are often regarded as something used for personal and social activities whereas laptops may be seen as business or education tools. Yet either laptops or mobile devices are equally capable of entering both worlds. With the five-institution mobile assessment Project MED, the challenges of taking a handheld device into the healthcare world are only too apparent. Not only do the healthcare providers view the devices suspiciously and see them as an added security risk but also the service users will react to them in different ways. If it is accepted that likely future strategies are based on using students' own devices, and that was the majority view from the field research, then institutions would not be able to control the features of the device. Hence students would have to be accepted in healthcare with devices that could take pictures, make movies and record sound. These cultural battles are yet to be tackled. Some interview respondents' saw applications for the mobile assessment technology in teacher education but education providers are already engaged in a struggle with students using their devices in inappropriate ways (Cook et al.,

2011) and questions remain over the cultural effect of having trainee teachers being seen using handheld devices in classrooms. This is an issue that makes *m-learning* different and is one to which answers will have to be found if embedding of in-situ applications is to become accepted practice.

There is another important point to recognise here as the word disruptive has a dual meaning in this context. Mobile learning literature refers to disruptive devices as challenging the control and authority of the institution (Traxler, 2010a) and indeed that is the view that some healthcare providers have taken in project MED, fearing unethical disruption in a clinical environment. But *m-learning* is also a potentially disruptive innovation (Lettl et al., 2006, Christensen, 1997) in that it challenges the status quo of the institutional business model. It is really the disruption in the classroom that has been focused on in the mobile learning literature (Traxler, 2010a; Cook et. al., 2011), the potentially disruptive nature of the innovation to the institution itself is manifested with the impact on the IT strategy which is discussed below.

Fragmented IT Strategy. The initial field study (that took place in 2006 to 2007) showed that IT departments were not investing strategic thinking into *m-learning* and indeed in some cases were positively hostile to the idea that this could become a core supported technology. Even in 2010/2011 when the research for Project MED was undertaken, there was still evidence that some IT departments viewed *m-learning* and mobile technology in general as non-core. Subsequently there has been a significant uptake of smartphone and 3G technology by the general population (Ofcom, 2012) fuelled in particular by social networking

applications such as Facebook and Twitter. Growth in HE students ownership of smartphones has been exponential (Dixit et al., 2011) and perhaps now almost ubiquitous with many institutions responding by offering some form of mobile access to systems and enhancing Wi-Fi coverage to cope with much greater access on campus by students through various forms of mobile devices – be they netbooks, handheld tablets or smartphones. Despite a much more open and strategic view of *m-learning*, the fragmented structure of some HE IT departments remains a barrier to overcome, an ever stronger reason to create effective points of passage or boundary objects(Star and Griesmer, 1989) that can enable joined-up thinking. The evidence from the six institutions examined in this thesis shows that IT functions are often sub-divided across the institution by functions which include Desktop/Laptop support, network infrastructure, storage and IT infrastructure (e.g. email), learning technologies, corporate information systems such as Student Records and finally telephony. Any new technology that is introduced faces the challenge of this functional split but arguably *m-learning* is the most challenging as it can touch all of these areas. Adding to this functional distribution complexity, there is also the additional challenge within some institutions where IT provision is neither centralized or distributed creating a random hybrid structure where some faculties retain much greater IT independence based on historically strong 'local' networks. Evidence from the case studies would suggest that unless an institution is extremely pro-active in building a link between a projects and its strategy, the distribution and organization of IT Services is a barrier to transfer of knowledge that will not be easily overcome. Innovation theories also tell us that independence of departments and faculties acts as a barrier to embedding, as it prevents a

coordinated strategy being developed (Christensen and Eyring, 2011, Winter et al., 2000). The tension between central and distributed decision making also has an impact on the institution's ability to learn from *m-learning* projects and create a strategic plan which encompasses that learning (Burns and Stalker, 1961, Pervan et al., 2005).

The consequences of this IT fragmentation are that strategy is left badly informed by the results of local experimentation or, worse still, local networks are able to create and maintain solutions outside the control of the strategy These local solutions can remain invisible to both strategy and the rest of the institution and, in the worst case, lead to competing translations (Latour, 2005) such as the proliferation of similar services that appeared in the pilot case studies on text messaging (Project SMS). Reflecting on the definition of embedding adopted from the literature review and used within the research design, namely the existence of a process which will absorb local network outputs into global IT strategy, it is clear 'fragmented responsibility' is a major barrier that must be overcome. Implications of this for the study's actor network will be developed further in the next chapter. The next section will draw lessons for other researchers from the approach taken in uncovering these findings.

9.2 Reflections on Methodology

Perhaps the biggest challenge of the project was to find a methodology that could be transcribed into an ANT-analysis of an *m-learning* project. There were many papers and books which demonstrated highly-respected and often cited outputs using ANT (e.g. Walsham and Sahay, 1999, Latour, 2002, Star and Griesmer,

1989) but these contained little guidance on how the field research had been undertaken and how the analysis was developed from the data. The researcher had his preferred epistemological stance of interpretivism and pointers to what some of the issues might be with *m-learning* and institutions from initial field research, but no clear path could be seen towards a conclusion. Given the wide range of individuals, organization structures, policies, suppliers and other stakeholders involved in an *m-learning* project, how could sense be made of these networks? Latour describes the problem as keeping the 'social flat' (Latour, 2005, p. 165) and hints that researchers must go through a series of moves to arrive at an analysis, although he remains obscure about how this might be achieved in practice. Essentially the problems are to restrain the view of the global to some manageable set of actors, decide on possible links between the local and the global and finally connect all of this together, something Latour (2005) describes as a series of moves.

This researcher went through his own series of moves in order to flatten the social world of *m-learning* projects into something that could be written about in words and diagrams. The first key move was to choose case studies as the over-arching methodology. As chapter 5 explained, case studies are well suited to an exploratory project researching a phenomena that 'was not supported by a strong theoretical base' (Benbasat et al., 1987, p. 372). The case study method was chosen as an attempt to try to understand institutional embedding of *m-learning* , to 'investigate a contemporary phenomenon in depth and within its real-life context' (Yin, 2009, p. 18). The choice of a pilot case study approach with Project SMS came about almost by trial and error. Originally the research had

wanted to compare three institutions but in getting the opportunity to investigate Project MED (a five institution case), the researcher recognised that he would need to be better prepared to have any chance of looking for evidence that would help build a Law/Callon model, as the scale and complexity of Project MED significantly increased the effort required in terms of both practical field craft and data analysis. Thus, Project SMS became the support act to be examined before the main show, to test out the researchers' critical approach. In hindsight this proved an invaluable step, as it gave confidence that a set of interview data could be turned into an actor-network model and warned the researcher of the complexities of institutional IT provision. Thus the right questions could be asked in Project MED to unveil the subtleties of the different institutions' approaches to IT delivery. Having said that, there were still some surprises along the way and it was a major surprise to find that two institutions within Project MED had such a hybrid IT delivery model which was neither centralised nor localised.

The second move was derived from the definition of embedding as looking at the process by which outputs from local *m-learning* projects could be assimilated into institutional IT strategy. This definition and the selection of the Law/Callon local/global model essentially simplified the research design into two heterogeneous networks and focused the investigation on the links between them. This helped identify the appropriate people to interview and structure the interview questions to concentrate on that interface or point of passage. Without this simplification, the challenging interview and analysis workload would have been unmanageable for one researcher.

The third move was to use grounded theory as a tool for managing interview and observation data. Choice was partially influenced by the researcher's previous experience of using the method but also the feeling that the researcher's interpretations of data would formulate the emergent codes and themes from which an explanation could be built (Charmaz, 2000). It is worth reflecting on whose version of grounded theory has been used as there is some debate that since the original formation of the method, the principal proponents Glaser and Strauss have diverged in their approaches, Glaser criticising the Strauss & Corbin book for adopting a more formulaic approach to help researchers with implementing the method (Glaser, 1992). Although the Strauss and Corbin (Strauss and Corbin, 1998) approach proved a very useful and practical introduction to grounded theory for this project, on reflection the use of grounded theory in this research process is closer to that proposed in the original Glaser and Strauss text (Glaser and Strauss, 1967). The researcher has also been influenced by guidelines for grounded theory studies in information systems (Urquhart et al., 2010). Open coding (Glaser and Strauss, 1967) was used initially to identify the basic concepts or descriptive categories apparent in the data and then this was refined through a process of selective coding to generate the main constructs that are visible through the data (Urquhart et al., 2010). Through this process the research was able to identify the significance of problems such as the distributed responsibility for IT delivery that was apparent in some institutions. This was then modelled using Actor-Network Theory to scale-up the findings so it could be related to other theories and finally a process of theoretical integration has been achieved by comparing the revised

Law/Callon model with other theories such as Structuration theory or the Technology Acceptance Model (see section 10.3). The use of grounded theory also seemed to resonate with the Latour (2005) mantra of following the actors which appeared close to the aims of the case studies i.e. talk to and observe the actors and find out how these projects have developed. Recent grounded theory texts also recognize that meta-theories such as ANT are a legitimate tool for interpreting emergent theory that is grounded in data (Urquhart, 2010, p. 353).

The final move in this process has been taking the themes emerging from the data and mapping them into the Law/Callon model. This was a challenge at first but the pilot case study showed the possibility that was rewarded by modelling the different trajectories of the institutions within project MED.

The initial aim of the research was to do a comparative case study of three *m-learning* projects. The problems in gaining access in to one of the original candidate projects led the researcher towards the pilot and then large case study approach. Would the results have been better or more representative if three single institution projects had been compared? Fortunately Project MED could be described as a revelatory case (Yin, 2009) as not only was it unique nationally at that time but it clearly demonstrated different project trajectories for all five institutions, despite them working to a common technical aim.

Finally the question is asked whether the outputs of this project are robust and valid and representative of a sector picture? This is a challenge to prove as there are 'many plausible and useful sets of principles for interpretive research' (Klein

and Myers, 1999, p. 87). What can be stated is that the research has used legitimate methods such as Grounded Theory and ANT which have been widely utilised in many published works. A path from the data to the analysis is demonstrable and the resultant ANT based model was presented to key interview respondents and they agreed that it reflected the project trajectories within their institution. In addition the conclusions resonate with the wide body of *m-learning* and innovation literature. For this reason the researcher feels that they are defendable, the only cautionary note being the evolving nature of the smartphone and mobile internet world. Are the conclusions still valid in 2013 given that data was collected in 2010? This is a topic that will be reflected on in the final paragraphs of this thesis in Chapter 10.

What could have been done differently? Perhaps the only area not considered is whether more in-depth analysis could have been carried out on the actor networks that constitute Information Systems provision in UK universities. This turned out to be highly complex in some institutions and it is possible that in the researcher's limited exposure to parts of this network, some subtleties of the story could have been missed. However if such a detailed project had been undertaken, then the weight of analysis would have proved too complex and time-consuming for a single researcher. Enough data was gathered to make enough sense of the situation to create the actor-network models that research partners recognised as valid and insightful. Consequently what grounded theory refers to as saturation, at least for this researcher, was reached (Glaser and Strauss, 1967).

9.3 Chapter Summary

This chapter has examined the findings from the field research with respect to the embedding of *m-learning* and has summarised a number of key issues: notably the fragmentation of IT strategy and the need to offer students multiple services are key institutional issues that impact embedding. These have been illuminated through the use of the Law/Callon model to plot the project trajectories and these trajectories show important differences in the approach to embedding between the various Project MED institutions. Could that Law/Callon model be extended to provide a sharper theoretical focus on those differences? In the next chapter, the conclusion of this thesis, this ANT–based model will be reviewed and extended to develop further insights and a unique contribution will be demonstrated by contrasting the resulting model with other approaches for examining innovation trajectories.

10. Contribution and Further Work

The previous Chapter (Chapter 9) examined *m-learning* issues that emerged from the field research and reflected on the effectiveness of the research methodology. The theoretical focus of the research has centred around Actor-Network Theory particularly the work of Law and Callon (1992) on the role of people and artefacts in forming a link, or point of passage, between local and global networks, in this case between *m-learning* projects and institutional IT strategies and services. This final chapter of the thesis focuses on its contribution to theory and particularly the development of an extended Law/Callon model that could be applied to other Information Technology projects. This is the major contribution of this thesis and is highlighted in this separate chapter to give it prominence. This extended Law/Callon model is also compared to other models of innovation to clearly differentiate it.

This contribution of an extended Law/Callon model and the *m-learning* embedding issues (Chapter 9) also has a contribution to practice for the sector. This concluding chapter also discusses ways that institutions can treat IT research projects which can facilitate the embedding process or at least ensure that strategy is informed by the experience even in the case where deployment of the project outputs isn't appropriate at that time.

10.1 Actor-Network Theory –the theoretical perspective

Law and Callon's work in developing the concept of the local and global network identifies "points of passage" as a key factor in whether both networks become bound in achieving a shared objective. What are points of passage in the context of these *m-learning* projects - are they people, processes or artefacts? The answer, as one might expect from an Actor-Network Theory perspective, is they can be any of these. Within the six institutions where activities were investigated, the examples found were:

- An individual who establishes themselves as a link between the two networks determined to use the local project as a vehicle for achieving new services within the global university space. Examples of this are the individuals in University C and B within Project MED.
- An IT Strategy document. If a local project is able to influence this artefact then this gives an opportunity to input to future strategy or at least ensure that the local project experience is captured for the future. There were no perfect examples of this in the case studies. Perhaps the closest fit would be University C where there is a clear global institution perspective in using mobiles to access university systems.
- A strategy group or blue sky thinking group whose job it is to investigate and make recommendations on future technology that the university may need to invest in and support. There are some examples of these groups in the case study, such as the "learning spaces" group in University A or the "mobile futures" group in University D. Whether this is an effective point

of passage remains to be seen. For example, in university A it does not seem to have succeeded in capturing the input from the project and in university D, there was no clear evidence that the university has moved forward in a mobile sense.

- Learning and teaching committees or cross-university groups of people such as teaching fellows. Successful support from these networks of new learning technologies can lead to influence on the IT Strategy as these groups can have good links into the university Executive. There is some evidence of this approach in University B and to a lesser extent D and E.

Law and Callon (1992) discuss the degree of attachment of actors in the global network and the 'capacity of the project to establish itself as an obligatory point of passage between the two networks'(Law and Callon, 1992, p. 46) as a key factor. The term obligatory is used to define the influence that a point of passage has to control and influence global resources. Only perhaps in University C was there an obligatory point of passage in the form of a well-placed individual actor supported by their immediate management. In this case it is possible to trace an impact on the global network, an advancement in offering that is clearly visible and an impact on the IT Strategy of the institution.

Law and Callon (1992) and Heeks and Stanforth (2007) who used the model in IT, both looked at top-down projects in the national sense, projects that were driven by needs that came from central government. These bottom-up *m-learning* projects required only a small amount of support from the global network and were able to maintain themselves from either local departmental/faculty or externally provided funding. Hence projects can be successful (in the case of text

messaging) and perhaps even locally embedded, but do not create the links into the global network, which the organization requires for embedding to be performed in a controlled and strategic way. Local networks can also proliferate in the absence of global support or intervention, leading to isolated translations (as in the case of University A) or worse still competing translations as in the case of the pilot text messaging study (Project SMS). The Law and Callon (1992) model could be adapted to try to explain these situations that the existing model doesn't focus on. Factors that seem to be significant to consider when adapting the model would appear to be:

- Lack of a formal embedding structure or route between pilot projects and IT strategy. This leads to failure to capture the lessons from pilot projects and a potential danger of repeating the learning curve in the future, a missed capacity-building opportunity. If a view is also taken that these new learning technology innovations need to be teacher/student led then there is also an issue in establishing a point of passage between learning and teaching strategy and IT strategy.
- The fragmentation of IT organizational structures in UK universities where functions may be distributed amongst different sections of the organization making it difficult for overall IT strategy to create a holistic view of all the impacts of new technologies.

To experiment with these factors, it is worth re-drawing the Law and Callon model with these factors considered to see whether this helps explain and understand the issues observed in the case studies. Law and Callon discuss the

degree of attachment of actors in the global network. The proposed model can be more specific about this degree of attachment and look at the strength of the point of passage from the local network to the global network in terms of links to IT Strategy. It can also consider the fragmentation issue encountered in UK HE IT delivery structures, the separation of functions or sometimes-arbitrary division of responsibilities. This, in itself, is an actor network whose coordination is dependent on a common central IT strategy. The less coordinated this is then the more likely it is that results of projects are not encapsulated in forward thinking. The following diagram (Figure 16) attempts to model this scenario:

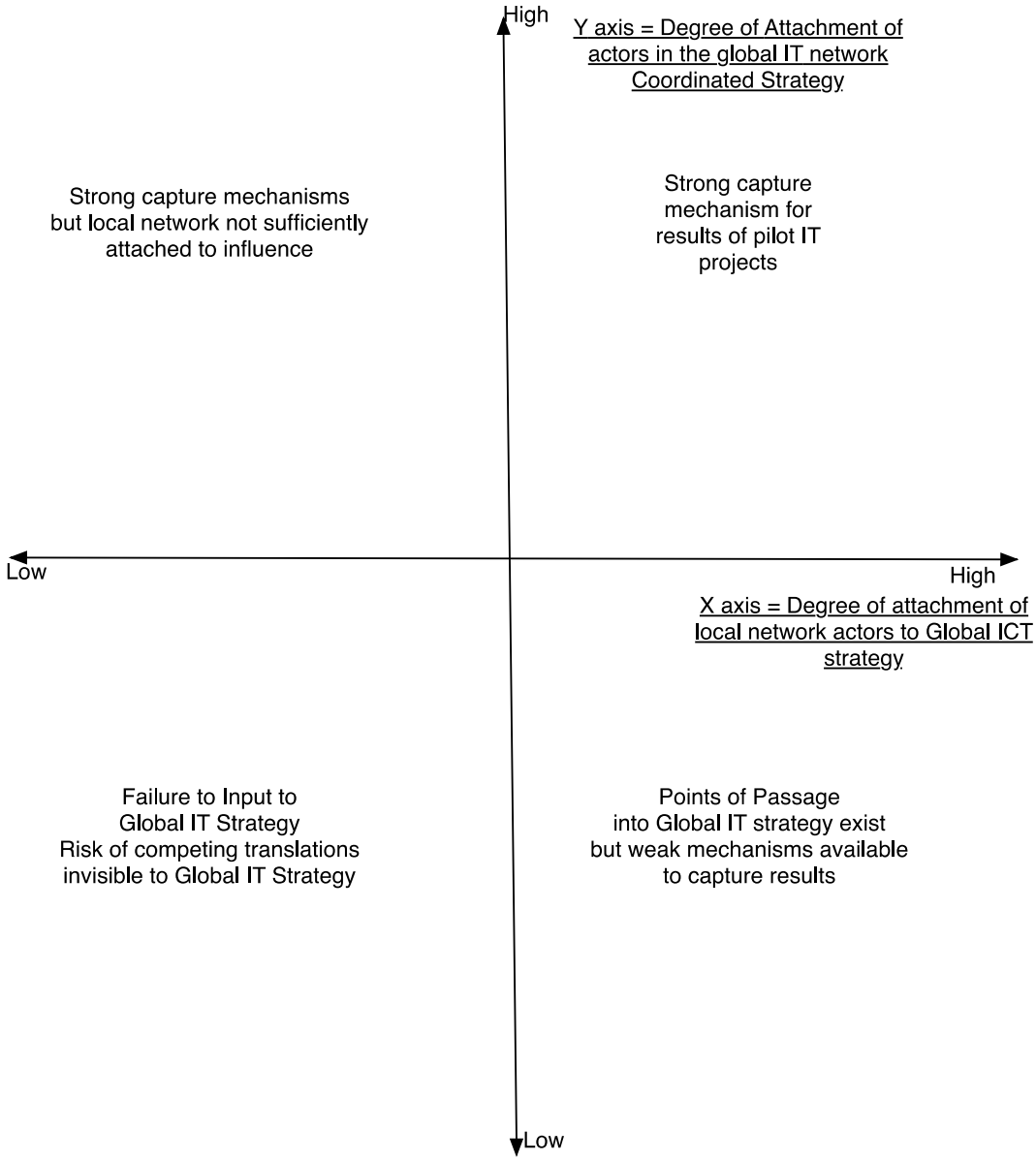

Figure 16 – Revised Law/Callon Model

The four quartiles represent the different scenarios that can occur. For an IT innovation to have the best chance of influencing the University IT strategy there needs to be both a strong point of passage into the global network and the global network needs to have a well-coordinated local network of its own which knits together the various strands of IT service offering. The consequences of both these factors being low i.e. a weak point of passage and a poorly coordinated IT

service are not necessarily failure for the local project which has no immediate effect on the global network but worse still allows the local project to exist and perhaps be replicated elsewhere without the framework of a global network strategy. To test the model on the case studies, University A from the five-institution mobile assessment project, Project MED, is examined. In order to simplify the analysis then the seven stages plotted on the Law and Callon model in chapter 8 can be reduced to four stages as follows (Table 15):

Stage	Description	Definition
1	Project Launch	Phase A (Initial Idea)
2	Feasibility	Phase B (Pilot) Phase C (Technology Choice)
3	Implementation	Phase D (Procurement) Phase E (Implementation) Phase F (Final Project Service)
4	Embedding	Phase G (Embedding)

Table 15 – Reduced stages Project MED

The trajectory of university A in the mobile assessment project is now plotted using the revised model that focuses on IT strategy (Figure 17):

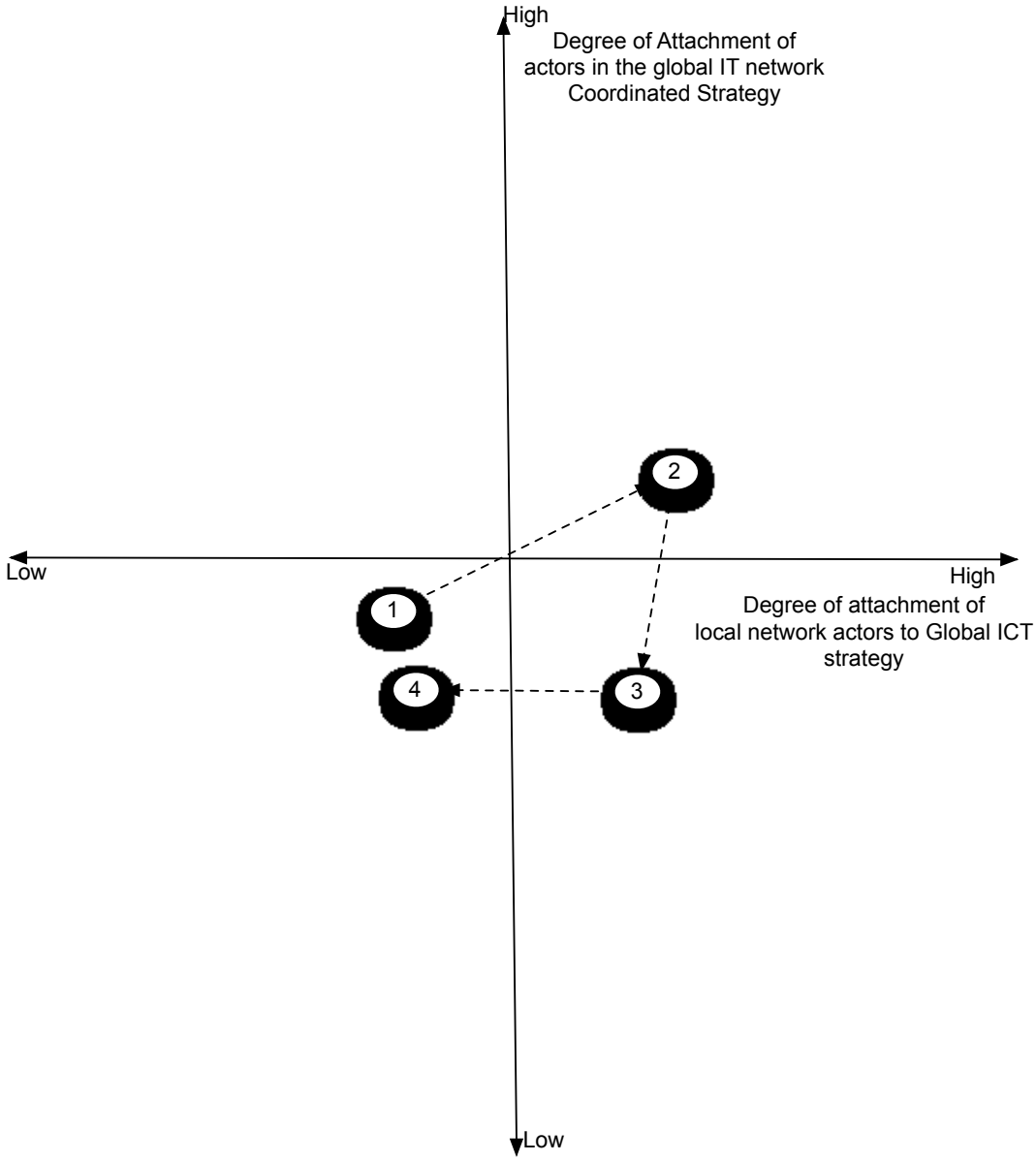

Figure 17 – University A plotted with the Revised Law/Callon Model

When Project MED started, connections to the global network were weaker, not helped by the distributed nature of the IT organization and the considerable self-sufficiency of the medical school in managing its own IT offerings. Through the feasibility and pilot and procurement phases (2) links to the global network were built and some interim coordination of the IT Strategy was started by actors in the global IT network who invited actors from the local network to participate

(the “learning spaces” project). As the mobile assessment tool is launched and tested by the students (Phase 3), links to the global IT network and the coordination of actors in the global network started to diminish. Evidence for this (contained in the chapter 8 analysis of University A) was demonstrated most strongly by the failure of the global IT network to request mobile connectivity in an invitation to tender for a new VLE. When the project came to embedding (phase 4), most departments (such as Nursing) decided they could not continue due to poor feedback and lack of funding. However, the School of Medicine was able to get funding for devices and therefore able to take forward the application independent of the global IT strategy, potentially leading to competing translations (multiple local *m-learning* implementations) in the future.

However, this model appears to miss some of the situations that the Law and Callon model captures. For example the existence of a strong point of passage and a well-coordinated IT strategy does not guarantee embedding. The technology may prove to be unsuccessful and the local and global networks may agree on this or find the technology too expensive, e.g. the global network is unable to provide the resources to support it. What is being attempted to capture here is the combination of local networks, global networks and being more specific about the capability of the organization to encapsulate the results of pilot projects in its IT strategy. The Law and Callon model seems to capture the possibility of innovation failure. Indeed explanation of the cancellation of a military aircraft project (TSR.2) that was deemed too expensive to complete, played a key role in the development of ANT. Without the support of the global network (in that case the Ministry of Defence, armed forces and other

institutions) then the project was doomed to failure (Law and Callon, 1992). However Project MED and Project SMS have demonstrated that, even without the support of a central IT strategy, it is possible for local network innovations to develop and in some cases in multiple locations. It is also worth exploring the links between the central IT strategy and the local network. Even in cases of project failure, that failure may be increased if the central IT strategy does not capture the lessons learned. The next step is to extend the Law and Callon model to also capture the links between local networks and the global network in a more explicit IT sense so the issues observed in these case studies can be tested.

The initial attempt to model the IT points of passage looked at two factors, the degree of attachment of local network to central IT strategy and the degree of attachment of actors in the global IT network (representing the fragmentation of IT responsibility). Both these factors could be combined with the Law and Callon model generating a four dimensional view of the project trajectory. However this is difficult to envisage and represent so perhaps if the two IT specific factors could be combined into one, a three-dimensional model might be achieved which can be practically visualized and used. The IT specific factor could be expressed as “Degree of attachment of all actors to the global IT network”. This reflects both issues: the point of passage from the local network to the global IT network but also the coordination of the global IT network, whether it is joined-up and can capture the local networks’ input efficiently or is fragmented in a way that makes this difficult.

The proposed model now has three axes:

1. The X-axis which is the “degree of mobilization of local actors” as per the Law and Callon model.
2. The Y-axis which is the “degree of attachment of actors in the global network”.
3. The Z-axis which is the “degree of attachment of all actors to the global IT network”.

Using the new model, University A’s project trajectory can now be examined as follows (Figure 18):

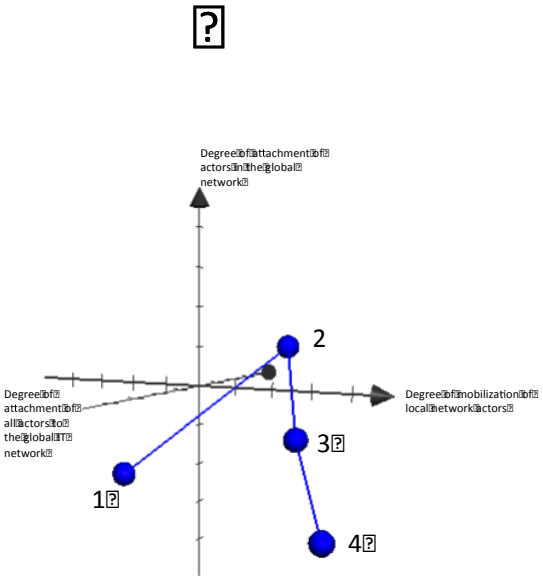

Figure 18 – Three-dimensional Law/Callon model with IT specific axis

To explain the diagram in terms of the project trajectory for University A, the following table (Table 16) is used:

Stage No	Degree of mobilization of local network actors (x axis)	Degree of attachment of Actors in the global network (y axis)	Degree of attachment of all actors in the global IT network (z axis)
1	Initially this is growing with early momentum	At the start this has impetus as the project is high-profile and an opportunity to learn	This starts from a low point given the distributed nature of the IT structure and faculty independence
2	Growing momentum as the pilots take place and choice of technology is made.	Became involved with the procurement process but no real connection on the technology choice.	Temporary coordination put in place through learning spaces project.
3	Starts to fall as technology problems dominate activities.	Apart from occasional attendance at meetings, interest appears to fall back.	Evidence of lack of effective coordination in the form of procuring a VLE with no mobile access.
4	Falls back as no embedding occurs in most subjects. However medicine implements an iPhone based solution.	Not involved as Medicine goes it alone – invisible to the overall strategy.	Lack of coordination means that high-risk of faculties developing local solutions.

Table 16 – Stages of three-dimensional model

The model can be expressed in table rather than graph form to show what the characteristics will be of combinations of the three (X, Y and Z) factors (Table 17):

Degree of mobilization of local network actors (x axis)	Degree of attachment of Actors in the global network (y axis)	Degree of attachment of all actors in the global IT network (z axis)	Comment	Example of Institution from this Research
High	Low	Low	This represents the scenario where the local project is a success but fails to receive any support from the global network both in a general or IT sense. It could lead to a local solution being adopted which is invisible to IT strategy	Examples here are the institution in Project SMS which leads to competing translations or university A in Project MED which implements a local solution at project end without involvement from global IT services or strategy.
High	Low	High	Although the local project fails to make the business case to the global network, there is an effective point of passage to the IT strategy so project lessons can be captured.	An example here would be university B in Project MED where there is no embedding but there appears to be good coordination across the IT services and teaching and learning strategy meaning lessons should be captured for future use.
High	High	Low	Project continues and will probably embed but without being effectively captured in the overall IT strategy.	
High	High	High	The ideal situation, successful project embedded into IT strategy.	University C is closest to this situation. It can be argued that the actual assessment project failed but has been successful in capturing the experience and building capacity into its IT strategy
Low	Low	Low	Project failure.	University E seems closest to this situation. Project failure but also little evidence of capacity building into central IT services.
Low	Low	High	Project failure but lessons captured in IT strategy	University D would seem closet to this. No interest in continuing the project but some evidence that good links with central IT services was established.
Low	High	Low	A situation where global network supports a new technology in a top-down approach but neither the local network or IT strategy is supportive of the change.	
Low	High	High	Represents a top-down project imposed by the organization onto a less than enthusiastic workforce.	

Table 17 – Combinations of Factors in the three-dimensional model

From the scenarios examined in the table above (Table 17), the model does interpret the issues that emerged from the case studies and is also potentially able to illuminate other possible scenarios where there is a mismatch between organization strategy, IT strategy and local implementations. It can be applied to the six institutions that were examined during the research and the last column of the table shows the scenario which best fits each of the institutions. It is also worth noting that the concept of 'degree of attachment of all actors in the global IT network' does represent the definition of embedding discussed in the literature review and methodology. That is the existence and effectiveness of links between the *m-learning* project and the institutional ICT strategy. The next section will reflect on this revised Law/Callon model and what this contribution means in ANT terms and whether this is an augmentation of Law/Callon's theory that could be developed and used to look at IT innovation embedding more generally than just mobile technology innovations.

10.2 The Contribution to ANT

To test whether this thesis has extended the application of ANT within the IT domain then it is worth considering three questions:

1. Does this application of the Law/Callon model offer new insights and a contribution in its own right?
2. Does the concept of agnosticism (Callon, 1986a), the equal treatment of human and non-human actors, add value to the study in the case of *m-learning* technology?

3. Does this project and how it demonstrates a path from interview data and observations to a diagrammatic analysis of Actor-Network translations, help other researchers using ANT, going some way towards solving the 'problem of description' (Walsham, 1997, p. 497) that many critics see in the often abstract and theoretical approach of much of the ANT literature?

Extending the Law/Callon Model. Given the scarcity of papers referring to this model, that alone is one justification for experimenting with it on this project. There is also an important difference to previous studies: this study has followed a bottom-up project initiated at the local network level whereas the frequently cited ANT studies (e.g.Walsham and Sahay, 1999, Heeks and Stanforth, 2007) are of projects started through top-down national government directives. These bottom-up projects highlight a recent phenomenon in which IT innovations in the wider world are tempting actors to try those innovations in their local environments. Local networks are forming to embed them in scenarios where the global network may not be supportive and where there may be no path to transfer the knowledge and expertise to the global network, a translation which is surrounded by a 'black box' (Callon, 1986b, p. 33) and lacks any point of passage into the global network. Any IT innovation could potentially cause this behaviour (e.g. Web 2.0 Technologies) but *m-learning* has caused particular strains on IT strategy where departments have not known how to categorise it: is it just some niche technology, which is department or subject-specific, or is it a mobile phone like the corporate BlackBerry and therefore best categorised as telephony, or does it have the same status as a laptop, something for which a support model must be found and access granted to our systems and learning

technologies? The uncertainty created by *m-learning* and its inability to sit within a convenient existing black box (Callon 1986b, p.33) has been compounded by a generic issue within UK HE IT: the fragmented coordination of IT strategy.

This fragmentation seems to be the result of two factors. A historical power battle (Becher and Trowler, 2001) between faculties and the centre is still being waged, some accepting centralised IT provision but others managing large parts of their IT infrastructure, which creates a natural barrier to widespread diffusion of innovations. At least two of the six institutions researched demonstrated that problem. The second factor seems to be a result of a piecemeal introduction of enterprise-level systems into Higher Education, where a number of separate departments have been created or have been given responsibility for pieces of the central software provision, learning technologies, timetabling and student records are prime examples. This second factor appears to lead to situations where no actor, be it the institution IT director, the IT strategy or the Executive has a holistic view of the IT requirements and hence any new technology such as *m-learning* finds it difficult to create points of passage into all these disparate pieces of the strategy. All six institutions appear to suffer from this problem to some extent with University C in Project MED appearing to have made the best attempt to bridge all those barriers.

The Z-axis in Figure 18 ‘Degree of attachment of all actors in the global IT network” captures explicitly this IT specific phenomenon. It encapsulates the two factors described in the last paragraph, the fragmentation of IT responsibility and the lack of connections between different pieces of the overall IT strategy. The

model adequately interprets the project trajectories of all six institutions from project SMS and project MED. More importantly it helps a researcher focus on the more extreme cases within the six institutions, University C which has made the best attempt to build capacity from a local *m-learning* project and University A in project MED plus the university from Project SMS which created successful local translations seemingly blackboxed and lacking a point of passage into the global network. The extension does help understanding of the complex actor networks that exist in HE and highlights a core issue, the fragmented nature of the sector IT strategy, which can throttle the introduction of *m-learning* or other IT innovations into HE. This contribution offers clearer insights for IT innovations than the existing Law/Callon model and has the potential to be developed further if tested on a number of different scenarios.

Agnosticism. The most often discussed and criticised feature of ANT is the concept of a level playing field for human and non-human actors, creating symmetrical networks that enrol all actors and treat them with equal significance. It is perhaps easier to accept that another living organism, the scallop, has a big part to play in the success or failure of the French scallop fishing industry in one of the classic ANT texts (Callon, 1986a). However it may be less easy to accept the role of the technology in another seminal study, the failure of a project to implement a driverless transit system for Paris (Latour, 2002). On the other hand the study of the failure of a military aircraft project, which inspired this research, barely discusses this aspect of ANT (Law and Callon, 1992). So what did this concept add to the analysis of project SMS and project MED?

At first glance, it could be concluded that the key issue raised, the lack of links into IT strategy from local projects, a failure to build capacity, is simply another failure of human actors not communicating effectively with other human actors, or groups of people working in silos and failing to join their ideas together. That is certainly a big factor in this research. However in examining Project SMS, the influence of the technology is apparent in that its low cost allows different parts of the institution to procure their own solutions. In addition, the lack of a set of over-arching requirements for the whole institution i.e. a strategy encourages proliferation of solutions as one party's chosen product can't support the needs of another. As an actor then, affordable text-messaging technology is indirectly influencing the behaviours of human actors in the network or tempting the other actors into a series of competing translations. The study of Project SMS also introduces the non-human actor of IT Strategy, which might be a document or collection of policies or in ANT terms, a heterogeneous network of human and non-human actors involving IT Directors, policies, strategy documents, University strategic plans and numerous IT staff. This actor network and its inability to gather all these inputs into a coordinated performance of shaping actions consistently on the ground, is the main focus of the failure to establish points of passage between the local and the global and a justification for extending the Law/Callon model with a z-axis. The symmetrical view proposed by ANT has proved a useful lens in highlighting these strategy problems.

Turning to Project MED, the same issues of IT Strategy coordination are only too apparent, but what about the role of the technology in the actor network? Given the relative failure of the mobile assessment application to engage students

and staff, has the actor technology influenced the direction of the project? Perhaps it did in the form of disruptive change as part-way through the project 3G network speeds became the norm and rendered the project 2G speeds as too slow by comparison. Perhaps even more dramatic was the appearance of the iPhone which had such a disruptive effect as an industry step-change, finally driving exponential growth of the mobile internet (West and Mace, 2010). From the project's perspective it was akin to someone driving a brand-new Ferrari into the university staff car park, staff and students seeing the project device as obsolete and decaying compared to this sparkling new product. Hence technology change may have hastened the demise of the project solution although conversely it showed what the future could be with a better handset platform, an opportunity which University A was able to find funding to explore. There are therefore, instances in the research where the equal treatment of human and non-human actors has aided this interpretation of *m-learning* embedding, a contribution to theory. However this aspect of ANT has not been the major focus, and indeed investigation of the contribution of these non-human actors could generate new opportunities for future researchers.

De-mystifying ANT. As a career IT person, the immediate reaction of this researcher on discovering ANT was "*it's a network yes, but where are the pictures, flowcharts, diagrams and models which represent an actor-network?*" Latour's recent introduction to the theory (2005) contains not a single diagram or picture to help the reader. Many seminal papers using the subject say little about how to turn a collection of data into an Actor-Network analysis from which conclusions can be drawn. The problem that researchers using ANT find is how

to start, faced with the 'loose guidelines on how to analyse in ANT' (Mitev, 2009, p. 14). This thesis has shown a clear path to an ANT analysis with pictures and tables starting from interview and observation data, using coding techniques borrowed from grounded theory (Corbin and Strauss, 1998) and then using the Law/Callon model to show the embedding trajectories of the case study institutions. The 'problem of description' (Walsham, 1997) has at least been conquered in this instance and is a useful model for future ANT-based researchers, which is a significant contribution to field research methods.

The next section will reflect on this revised ANT model and compare it with other technology introduction models such as innovation diffusion theory (Rogers, 2003), the innovation models proposed by Christensen (1997), the Technology Acceptance Model (Davis, 1989), Activity Theory (Engeström, 1987) and ideas developed from structuration theory (Giddens, 1984) about technological frames of reference in an organization (Orlikowski and Gash, 1994).

10.3 A Comparison of the Enhanced Law/Callon Model with other innovation theories.

The literature review (chapter 3) considered a number of models that covered the embedding of innovations into a market, sector or organisation. Taking the enhanced Law/Callon model proposed in this chapter, this section will reflect on the value of this proposed enhanced lens over other innovation theories and models, and highlight the distinct contributions it can bring.

Innovation Diffusion. Rogers (1962) innovation diffusion theory was an early starting point for this research, what could it offer to breakdown the issue that might occur with the embedding of *m-learning*? Rogers theory clearly puts the innovation as the central focus of his model whereas this Law/Callon extension is focussed on the gap in the organization between the local network and the global network. Rogers does cover this issue to some degree with his concept of 'interconnectedness' (Rogers, 2003, p. 412), stating that innovation is helped if the members of an organization have strong interpersonal networks, perhaps a hint at the ANT concept of point of passage. Given perhaps the apparent failure by most central university IT organisations to encompass the *m-learning* projects into their future strategy, there is also an element of 'passive rejection' (Rogers, 2003, p. 178) where parts of the organization have never really seriously considered *m-learning* as a strategic need. Whilst it might have been possible to use Rogers theory to explain the trajectories of Project SMS and Project MED, it would not have given such a sharp focus to the point of passage or lack of interconnectedness and might not have exposed the issue that the structure of some HE IT organisations has such a profound impact on the ability to build capacity. In addition, such a study might all too easily have concluded that the innovation was a failure (given the lack of success of the Project MED devices), which would be too simplistic given the diversity of the end results in the different institutions.

Disruptive/Sustaining Innovation. The literature review considered Christensen's theories of the impact of innovation on organisations and industries, whether an innovation is sustaining (i.e. fits the status quo) or

disruptive and causes the organisation or industry to change radically (Christensen, 1997). It is most effective when applied retrospectively, and given the research has been carried out at an early stage in the introduction of *m-learning*, this was not an option. It is also difficult to generalise *m-learning* as either a disruptive or sustaining innovation, as *m-learning* could be seen as a development of e-learning, something which has been around for a while without causing massive sector change (Christensen and Eyring, 2011).What can be stated is that *m-learning* is one of a series of issues encompassing both new technology and regulatory and financial change which challenge the status quo of the university sector and require an organisational 'change of DNA' (Christensen and Eyring, 2011, p. 398) to meet such a challenge. The term potentially disruptive is more appropriate in the context of *m-learning* and HE. It might well be appropriate to use Christensen's theories to look at *m-learning* and its impact in this regard but only when the impact can be measured, i.e. in 5-10 years' time. At the time of this research, only *m-learning* strategies which appear more likely to succeed than others can be examined, something which the Law/Callon model has placed in sharp focus.

Technology Acceptance Model (TAM). This model has been useful in reflecting on some of the issues involved with embedding *m-learning*, notably the concept of user perceptions of the technology (Venkatesh and Davis, 2000). Poor user perceptions of early generation smartphones used in Project MED appeared to throttle any attempt to revive the mobile assessment application as it was developed, even if many of the early installation problems had been rectified. User perceptions of mobile internet technology and smartphones were

radically altered by the appearance of the iPhone and there has been exponential growth in ownership of smartphones and using the devices to gain internet access (Ofcom, 2012). However the lens of the Technology Acceptance Model does not illuminate the sort of issues that the enhanced Law/Callon model supports, that has never been the TAM's focus, and consequently it has rightly played only a small part in this study.

Activity Theory. This was perhaps an alternative to ANT in that its ability to breakdown events into discrete activities which are networks themselves (Leont′ev and Hall, 1978, Engeström, 1987), might have shed some insight onto the workings of the development of an *m-learning* strategy. Activity theory seems better suited to looking at networks of learning and learning activities (a view clearly shared by many mobile learning researchers (e.g. Sharples et al., 2007)) but it does appear to be weaker in looking at links between networks, 'the boundary objects' (Spinuzzi, 2008, p. 206). Strong emphasis is placed by Activity Theory on development tasks, with less focus on the interactions between those tasks. The aim of this research is looking at how *m-learning* projects became linked to overall university strategy and thus "points of passage" or "boundary objects" were a key focus and hence ANT was chosen. Perhaps another reason is that the *m-learning* research community has focussed on pedagogy using Activity Theory so, although the focus of this research is certainly not pedagogy, using ANT is a clear break and distinction from the existing *m-learning* research community: a unique contribution.

Structuration Theory. Giddens structuration theory (Giddens, 1984) looks at the relationship between individuals and society, proposing that social phenomena are the product of both social structure and human agency – people draw on social structure to determine their actions and in turn these actions produce and modify social structure. Structuration theory focuses on the agency of humans and does not include the thought of agency of objects unlike ANT. At the start of the research, *m-learning* was an immature technology and there appeared to have been little consideration of how it might be integrated in UK HE IT structures and strategy as it was largely being used in localised research projects. The ability of the technology to influence those structures as an actor attracted this researcher to Actor-Network Theory as a more promising lens. However, work on technological frames (Orlikowski and Gash, 1994) would seem to get closer to the issues that the Law/Callon model has exposed, looking at cases where 'assumptions, expectations and knowledge of technology are collectively held' (Orlikowski and Gash, 1994, p. 199) by different parts of an organization. A lack of collectively held views, as has been demonstrated in the absence of links between projects and central IT strategy, could well be a synonym for a lack of a point of passage. Another example may come from Project MED where the appearance of the iPhone created a 'technological frame' that set expectations of smartphones that the 2G project devices could not meet. A comparison between ANT and structuration theory might also invoke the ontological debate 'how do technological innovations change the opportunities and constraints in the social order and how does the social order change technologies' (Greenhalgh and Stones, 2010, p. 1293). In this case, the immaturity of *m-learning* when the research commenced made that question

difficult to answer within the research timescales as the social order of IT provision within HE had not attempted to adjust to *m-learning* in the majority of the institutions within Project SMS and Project MED. A more realistic goal was to focus on the interface between the *m-learning* project and the IT strategy as the projects developed signs of embedding. The concept of point of passage and the agnostic symmetrical view of actors proposed by ANT provided a more focused method to examine the interface between the projects and the strategy and highlight a viable theoretical contribution in terms of extending the use of the Law/Callon model.

This section has thus considered many alternative theories of innovation diffusion or embedding that were available to the researcher at the commencement of this project. The use of ANT and the extended Law/Callon model over these other theories can be justified and the Law/Callon model provides novel insights at this stage of *m-learning* development in Higher Education.

10.4 Contribution to Practice

The contribution to practice comes in two parts, a deeper analysis of some of the specific issues involved with using mobile technology in Higher Education and the insights into new technology introduction methods that the extended Law/Callon model brings. The contribution on mobile specific issues is already discussed in the section "embedding issues in *m-learning*' that appears in Chapter 9 (Section 9.1). The need to provide access to as many systems as

possible via a mobile device is key to embedding of an *m-learning* initiative, single purpose usage as in the case of Project SMS and Project MED will fail to engage both students and staff. However this issue, given the research fieldwork took place in 2009 and 2010, may have been overtaken by events. The exponential growth in smartphone usage and usage of the mobile internet (Ofcom, 2012) mean that institutions are recognising that many students will access their systems from such devices and that is now more likely to be accepted as something that university IT departments must support and encourage.

The other key issue is a lack of a business model for providing students with phones or supporting the cost of data charges for applications that are mandated to satisfy course requirements (e.g. assessment applications). It could be said that such issues are disappearing as most students by now, will have smartphones, and university campuses have invested heavily in ubiquitous wireless access. However there will be still occasions where students may need access over mobile networks for instances such as clinical placements or field research in life sciences. There is thus still a need for the sector and the network operators to produce a model where this can happen and costs can be shared appropriately by the university and the student. Data-only tablet contracts may be a step towards it, but mechanisms that would allow students to top up an institutionally-provided baseline credit are still not obvious.

The contribution of the Law/Callon model to practice, is to highlight the issue where institutions have failed to build capacity when presented with R&D funding to investigate new technologies, *m-learning* being an instance of this. There has been considerable funding in *m-learning* experimentation within the sector and indications are this will now become much harder to obtain given the financial constraints on the sector that governments are now imposing. Given the slow development of *m-learning* (projects have been running since the late 1990s) then there is some risk that the opportunity to capacity-build presented by this funding may have been wasted on many occasions. The sector needs to have clear processes for trialling such technologies and ensure that lessons from those that are successful, or indeed unsuccessful, are incorporated into strategy rather than reinvented in a number of different parts of the organization as needs develop.

10.5 Where next for the research?

Three are four areas which would be promising avenues for future research:

1. **Testing the enhanced Law/Callon model**. This thesis has developed its theoretical contribution based on a range of bottom-up initiated *m-learning* projects and the enhanced model does appear to offer insights into their project trajectories. However there are many projects which are initiated in different ways such as through executive board directives so it would be good to test out this model in other scenarios. Perhaps another

way of testing the applicability of the model would be to present it to University IT directors through an organisation such as UCISA (Universities and Colleges Information Systems Association).

2. **The maverick innovator**. This project did, in its early stages, have the opportunity to research an institution where the *m-learning* project was 'under the radar'; the initiator was almost determined to keep her work away from the eyes of IT Services. This phenomenon of the bootleg or maverick innovator (Augsdorfer, 2005) is an innovation topic in its own right with an existing body of literature – most notably its links to the development of open source software and its networks of innovators (Chesbrough, 2003). It is a difficult topic to research as innovations that may seem 'maverick' may eventually find their way into the mainstream and be claimed by the institutional IT provision, a transient research opportunity. With the advent of smartphone development platforms such as iPhone and Android, the possibility of highly localised development of learning apps must be present and this might be another instance where the local develops applications without a point of passage to the global (perhaps a deliberate strategy by the local) leading to the potential of inconsistency for students as they utilise different learning apps and conflicts with central IT provision.
3. **The IT strategy network**. The fragmentation of IT responsibility is an issue that has been highlighted in this research and makes a holistic view of IT difficult to achieve in some institutions. This research was able to look at the points of passage between local project networks and the global IT network by interviewing and observing stakeholders on both

sides of the potential divide. However this point of passage is a complex network in itself involving both individuals, strategy documents, committees and, of course, the technology itself. Such networks could be studied across a number of institutions to model why some form into effective points of passage, whilst others fail to translate into a set of unifying requirements (Callon, 1991).

4. **Changing landscape**. The field research for this project took place between 2006 and 2011. Now in 2013, the *m-learning* landscape has undoubtedly moved on and smartphones and tablet devices are becoming ubiquitous amongst both the student and staff population of our universities. It would be interesting to look at some *m-learning* projects in the current time. Is the lack of strategic interest in the technology still a problem? Do points of passage now more easily open up from these projects and engage with institutional IT and learning and teaching strategies? What have standardised mobile offerings, such as CampusM, done to staff and student expectations of *m-learning*?

10.6 Final Reflections

This thesis began with the premise that use of mobile devices was a new and disruptive technology that was starting to appear in UK Higher Education. Taking note of the vast wealth of literature on *m-learning* pedagogy (e.g. Traxler, 2007, Sharples et al., 2007), it seemed that the research community was missing a key point: how would *m-learning* integrate itself into university organisations, business processes and, most significantly, the institutional IT strategy to become

an embedded and fully supported innovation? Starting from the premise that this was an innovation diffusion problem (Rogers, 1962), a number of innovation models were reviewed including Christensen (1997), Giddens (1984), Davis (1989) and Engestrom (1987), finally settling on Actor-Network Theory inspired by Latour (2005) but focussed on a more pragmatic interpretation of ANT proposed by Law and Callon (1992). Using the Law and Callon model, two m-learning projects were analysed: Project SMS a text messaging application as an initial pilot to refine fieldcraft and analysis techniques and then Project MED, a mobile assessment application involving five institutions. An enhanced version of the Law/Callon model has been developed which offers new insights into links between local *m-learning* projects and global institutional IT strategy: the major theoretical contribution of this thesis. In addition, contributions to practice have been made by highlighting some key *m-learning* issues and drawing attention to problems faced by UK HE in embedding the outputs of IT research projects into IT strategy. In performing this detailed Actor-Network analysis, a contribution to methodology has also been made showing a pragmatic way in which to achieve an actor-network analysis in a subject area where methodology is often obfuscated in theoretical language.

The preceding chapter (Chapter 9) has already questioned whether issues of *m-learning* embedding identified in the fieldwork are just as challenging in 2013, given the widespread ownership of smartphones and tablets, ubiquitous Wi-Fi and 3G coverage with 4G becoming available, and many respected industry reports reflecting on and predicting exponential growth in the use of mobile data and access in all sectors including Education (Ofcom, 2012, Johnson and Brown,

2012). There is plenty of evidence that the use of mobile devices in health education is growing, for example, with some medical schools (Dexter and Cappelli, 2012) but there isn't any published evidence either way to say whether this is being more effectively coordinated with IT strategy. There has also been considerable growth in the use of mobile portals such as CampusM so how is that being deployed if the outputs of this thesis hold true, as at least three of the institutions covered now have a CampusM offering? The answer is simple, these are self-contained top-down imposed applications introduced with the knowledge and support of senior management in the institution and which focus on the simpler administration information aspect of *m-learning*. The role of these mobile portals is to present data gathered from various university systems so as long as those involved cooperate in providing such interfaces and data, then the service can be delivered. Rather like VLEs, which are ubiquitous in universities, when the institution decides to procure a system centrally with the full knowledge of the IT strategy actor network, local networks will tend eventually to fall into line. This thesis has focused on a very different problem, that of a project that starts from the bottom-up and has to build bridges into the IT strategy, create a point of passage, and that may well still remain a difficulty at the current time. These is recent evidence that this is the case from JISC funded curriculum innovation projects where fragmentation of information management systems has shown difficulties in institutions being able to bring together the systems such as the VLE, timetabling, online curriculum and student records in a cooperating actor network, to present a consistent picture to all stakeholders (JISC, 2012). Notably the fragmentation of IT responsibility is a major factor in these problems. Thus the contribution of this thesis and its enhanced Law/Callon

model is extremely relevant to the UK HE Sector as it struggles to adapt to new funding regimes and government policy directives. Getting to grips with both m-*learning* and the problem with building locally driven initiatives into the global IT strategy are all issues which must be resolved for the sector to respond to new forms of competition, meet higher levels of service expectations from students and as Christensen puts it, change their DNA (Christensen and Eyring, 2011).

The enhanced Law/Callon model is a contribution to understanding this evolving process as it illuminates key issues when University IT organisations are faced with new innovations that are introduced from localised initiatives. The model places a sharper focus on the importance of establishing a path by which the local initiatives can be evaluated strategically by the central IT organisation and where appropriate be incorporated in a timely manner into the institutional IT strategy. The model has been developed and tested in this thesis through an analysis of *m-learning* projects but it has the potential to offer new insights into the introduction of other new IT innovations into both the Higher Education sector and beyond.

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